ROBOTS IN ASSISTED LIVING ENVIRONMENTS

UNOBTRUSIVE, EFFICIENT, RELIABLE AND MODULAR SOLUTIONS FOR INDEPENDENT AGEING

Research Innovation Action

Project Number: 643892   Start Date of Project: 01/04/2015   Duration: 36 months

DELIVERABLE 6.11

User evaluation report III

Dissemination Level	**Public**
Due Date of Deliverable	Project Month M30, September 2017
Actual Submission Date	March 2018
Work Package	WP6, *Piloting and evaluation*
Task	Task 6.4, *User evaluation*
Lead Beneficiary	FZ
Contributing beneficiaries	FHAG
Type	R
Status	Submitted
Version	Final

Abstract

This deliverable reports the findings of User Evaluation of the first round of Summative Phase of pilot studies. The ultimate goal is to evaluate the usability of the 1st integrated RADIO prototype for the primary users. The report includes a description of the measured variables, the analysis methods used, the results, and a discussion section describing the main findings and their implications

History and Contributors

Ver	Date	Description	Contributors
00	27 Sep 2017	Document structure	NCSR-D
01	28 Dec 2017	First draft	FHAG
02	16 Jan 2018	Internal feedback	NCSR-D
03	22 Jan 2018	Internal review	FSL
04	30 Jan 2018	Updates in all sections	FHAG
05	7 Feb 2018	Input in Section 3.2	FZ
06	7 Feb 2018	Input in Section 3.1	FHAG
07	12 Feb 2018	Input in Sections: 3.1.2, 3.1.3, 4	FHAG
08	16 Feb 2018	Input in Section 3.1.2	FHAG
09	20 Feb 2018	Input in Section 3.1.2	FHAG
10	26 Feb 2018	Internal peer review	FSL
11	28 Feb 2018	Addresses peer review comments	FHAG
Fin	6 Mar 2018	Final preparation and submission	NCSR-D

Executive Summary

This deliverable reports the results of user evaluation of the first round of Summative Phase of pilot studies. The ultimate goal was to evaluate the usability, impact to quality of life and obtrusiveness of the 1st integrated RADIO prototype for the primary users. Eight (8) elderly participants were recruited at FHAG's pilot study. Moreover, the RADIO system was also installed and tested at two (2) private residences from FZ's clientele. Each participant completed a three-day study protocol, during which they performed various repetitions of the monitored ADLs and they interacted with the RADIO system (robot and smart home) via the RADIO GUI. At the end of the study each participant was asked to evaluate the usability of the RADIO system (via SUS, PIADS and ASQ questionnaires), the impact of the RADIO system to the quality of life (InterRAI QoL –FHGA pilot only), and the obtrusiveness of the system. Overall, the assessment of usability of the RADIO system was positive. Regarding obtrusiveness physical and usability dimensions of the RADIO platform seemed to concern the participants. Moreover, affordability of the RADIO system came up as a potential constraint for its adoption. However, no concerns were reported concerning the self-concept, routine, privacy dimensions.

Abbreviations and Acronyms

ADL	Activities of Daily Living
ASQ	After-Scenario Questionnaire
IADL	Instrumental Activities of Daily Living
interRAI	International collaborative to improve the quality of life of vulnerable persons through a seamless comprehensive assessment system. Cf. http://www.interrai.org
interRAI HC	The interRAI Home Care Assessment System
interRAI LTCF	The interRAI Long-Term Care Facilities Assessment System
MMSE	Mini Mental State Examination
PIADS	Psychosocial Impact of Assistive Devices Scale
SUS	System Usability Scale
GUI	Graphical User Interfaces

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Purpose and Scope

The purpose of this document is to report the *user evaluation* of the execution of the first round of the Summative Phase pilot studies. The scope of the study was to run the first round of Summative Phase pilot studies at FHAG premises and at the private residences of FZ's clients. The objectives of this pilot were (a) to provide data for the user and medical evaluation of the first integrated RADIO prototype; and (b) to refine the piloting plan itself into its final version. The first integrated RADIO prototype included both robot and smart home functionalities.

Specifically, this document provides details about the usability of the first integrated RADIO prototype for the primary end-users. The document describes the analysis methods used, the results, and a brief summary discussing the main findings.

1.2 Approach

RADIO studies are conducted in three phases:

1. Formative phase; first pilot at FSL
2. Intermediate phase; second pilot of RADIO components at FSL
3. Summative phase; final RADIO pilots

This deliverable reports the *user evaluation results of the first round of Summative Phase* pilot studies at FHAG premises and at the private residences of FZ's clients.

This report is public. The procedures followed (without any reference to the particular subjects or deployments) are documented in public deliverable *D6.3 Piloting plan III*. The execution of trials and details about piloting, its outcomes and technical details are reported in *D6.7. Pilot report I* (restricted document).
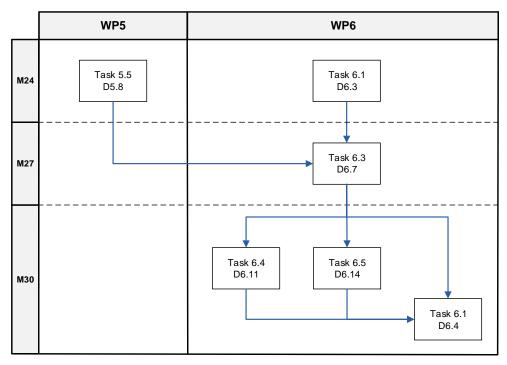
Figure 1. Dependencies between this deliverable and other deliverables.

1.3 Relation to other Work Packages and Deliverables

This document reports the user evaluation results of the first round of Summative Phase pilot studies These trials were executed at FHAG premises during May – June 2017 and at FZ clients' private residences during June 2017.

The study included testing the usability of the first integrated RADIO prototype (D.5.8)

The data collected during the trials were reported in *D6.7. Pilot report I.* These data were analyzed in the context of Task 6.4 and analysis results are reported in the current deliverable. Moreover, the data collected are used for *D6.14 Medical evaluation report II* in the context of *Task 6.5: Medical evaluation.*

2 METHODS

This section provides a brief description of the participants and the set-up. It goes on with reporting the testing scenarios. It then briefly presents the comprehension and usability evaluation data collected as well as the feedback received from participants during personal interviewing. It goes on with a detailed description of the statistical methods used.

2.1 Participants

2.1.1 FHAG participants

Eight (8) elderly participants were recruited. All the participants fulfilled the inclusion and exclusion criteria described in details in *D2.1 Early detection methods and relevant system requirements*.

Table 1 reports group demographic data and global cognitive status of participants at the time of the recruitment. Consistently with the inclusion and exclusion criteria, all the subjects were older than 64 years and no subject reported a MMSE [1] score ≤18 (they all had a minimum adjusted MMSE score of 22, individual data are reported in D6.7- which is a restricted document.).

Table 1. Demographic data of participants' group at FHAG study

Participant Number	Age (yrs)	Gender (f,m)	Adjusted MMSE	Education info
8	79.25 ±7.44	6/2 (F/M)	24.50±2.56	5±3.85

Each participant underwent an assessment on:

- ***Functional status:*** section G of interRAI LTCF [2] (see Figure 3)
- ***Mood-behavior:*** section E of interRAI LTCF [2] (see Figure 4)
- ***Cognition:*** section C of interRAI LTCF [2]
- ***Quality of life:*** Self-reported Quality of Life instrument [3]

Regarding the need of supervision in IADLs, according to the inclusion criteria specified in D6.3 Piloting Plan III, each subject needed supervision in at least two IADLs. ***Error! Reference source not found.*** shows the distribution of population for each item of the IADL scale [4].
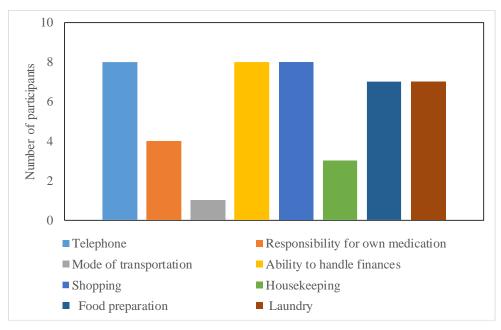
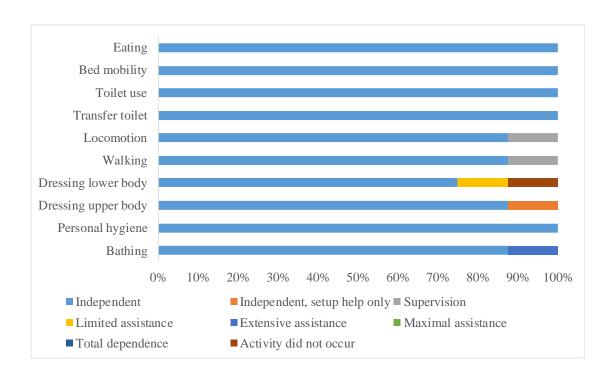*Figure 2. Need of participant population for supervision in IADLs.*

Figure 3. Need of participant population for supervision in interRAI LRCF Section G
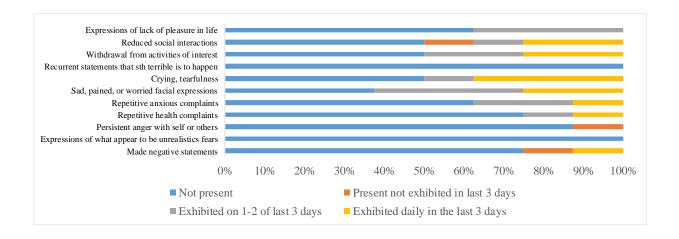
Figure 4. Need of participant population for supervision in interRAI LRCF Section E

2.1.2 FZ participants

Two (2) elderly participants were recruited. All the participants fulfilled the inclusion and exclusion criteria described in details in *D2.1 Early detection methods and relevant system requirements*; they were older than 64 years and no subject reported a MMSE [1] score ≤18. Regarding the need of supervision in IADLs, according to the inclusion criteria specified in D6.3 Piloting Plan III, each subject needed supervision in at least two IADLs.

Individual demographic data and global cognitive status of participants at the time of the recruitment are presented in D6.7 (restricted deliverable).

2.2 Evaluation Variables

After the experimental sessions, each user was interviewed about the *usability* of the early RADIO components through:

- System Usability Scale (SUS) [5];

- Psychosocial Impact of Assistive Devices Scale (PIADS) [6];

- After-Scenario Questionnaire (ASQ) [7];

Detailed information about these scales are provided in *D6.3*.

InterRAI **Quality of Life** (QoL) Survey instrument was also used to assess QoL of each participant at the end of the study, only at the FHAG pilots. It consists of 49 items grouped under 10 domains regarding privacy, food/meal, safety/security, comfort, making daily decisions, respect, responsive staff, staff-resident relationship, activity option and personal relationships. Questions are at a five level response, for all items, and a summary score ranging from 0-196 could be used for assessing overall quality of life, higher score better quality of life.

Finally, each participant at both FHAG's and FZ's pilot studies had a semi-structured interview regarding **obtrusiveness** according to Hensel's dimensions.

2.3 Statistical Analysis

Descriptive statistics will be used for characteristics of the participants including cognitive, emotional, and functional dimensions deriving from the standardized assessment instruments interRAI LTCF and interRAI HC. See section 2.3.3 on D6.2 Piloting Plan I and section 2.3.1 on D6.10 User Evaluation for further explanation.

Qualitative analysis was performed to study obtrusiveness among participants of the first round of the summative phase. Rationale for this approach is given in deliverable D6.7 section 2.5.1.

3 RESULTS

3.1 First integrated RADIO prototype at FHAG premises

3.1.1 Usability

This section presents the results of the usability of the first integrated RADIO prototype throughout different usability instruments already presented in D6.7 section 2.5.1: the System Usability Scale (SUS), the Psychological Impact of Assistive Devices Scale (PIADS), and the After Scenario Questionnaire (ASQ).

Table 2. Results of usability assessment of the ADL recognition system (end-users)

Scale	Outcome	RADIO's score
SUS		24.37
PIADS	**Competence**	1.36
	Adaptability	2.08
	Self-esteem	0.68
ASQ		0.88

SUS score under 68 is considered below average.

PIADS score meant to be either positive (+1, +2, +3) or negative (-1,-2, -3). Central tendency 0 defining absence of perceived change following the device use.

3.1.2 Quality of life

All participants fulfilled the questionnaire with no missing data. The median value of the Self- Reported Quality of Life Questionnaire was 177 (interquartile range 164.75-182.75). According to reported data most participants have always or most of the time positive answers regarding different dimensions of quality of life. The two QoL dimensions more closely related to RADIO project are those regarding safety and comfort which are part of the Staff Responsiveness subscale. Table 3 shows highest values in this subscale for RADIO participants

Table 3. Results of quality of life assessment

QoL subscales	Mean	Standard deviation	Mínimum	Maximum
Social Life Scale (0-30)	17.83	6.40	9.00	25.00
Personal Control Scale (0-24)	21.50	4.54	11.00	24.00
Food Scale (0-9)	8.38	0.92	7.00	9.00
Caring Staff Scale (0-15)	14.50	0.53	14.00	15.00
Staff Responsiveness Scale (0-24)	24.00	0.00	24.00	24.00

3.1.3 Obtrusiveness

In order to investigate elderly participants' perceptions on the RADIO platform, semi-structured interviews asking about Hendel's dimensions of obtrusiveness were conducted at the end of the study.

We have particular interest in assessing the usability dimension. The usability dimension is incorporated into the conceptual framework of obtrusiveness and is based on the concepts of ease of learning, ease of use, flexibility and robustness. In the field of ageing, usability stands out mainly for the level of satisfaction with easiness elderly people has had in using technology, an aspect intimately linked to the acceptance or rejection of the device. However, it would be also necessary to add aspects of final utility (effectiveness), not only of manageability of the process, to this concept. Overall, the RADIO system was regarded as easy to use but we have to take into consideration that the research assistant was helping the participants across all scenarios.

Has de aprender a usarlo...la sensación es que es fácil. Tiempo y esfuerzo no pero. – ***"You have to learn to use it… the feeling is that it is easy.*** *(You don't need)* ***Time and effort*** *(to use it)",*

No lo veo fácil, seguramente si lo han de hacer funcionar para los ancianos sí que vale un esfuerzo. No es fácil. – ***"I don't think it's easy, surely if they have to make it work for the elderly it is worth an effort. It is not easy".***

¿Para mi es fácil, pero para una persona mayor? Sobre todo, ahora que es aún un prototipo falla y hace falta transportarlo. Si funciona mejor y es autónomo para moverse perfecto. – ***"For me it's easy, but for an older person?... Especially now, that it is still prototype, it fails and it is necessary to teleoperate it. If it works better and moves autonomously … perfect."***

Regarding other obtrusiveness dimensions, people expressed some concerns about the *potential human substitution by robots (human interaction dimension)*:

Si necesitase ayuda preferiría una persona. – ***"If I needed help I would prefer a person."***

No puedes hablar con el. – ***"You cannot talk to it (robot)."***

No es bueno estar demasiado tiempo en casa necesitas salir y relacionarte. No quiero un robot. – ***"It is not god to stay too much at home, you need to go out and have relationships. I do not want a robot."***

Many participants complained about the inability to communicate to the robot and this could be regarded as obtrusive from the *function dimension* (suboptimal performance). However, regarding the same dimension, most positive inputs came from the potential effectiveness or final utility of the platform regarding safety aspects and facilitating independent living in an unobtrusive assisted environment.

> *Buen soporte en caso de urgencias.* – ***"Good support in case of an emergency."***
>
> *Me siento muy seguro.* – ***"I feel very confident."***
>
> *Te da seguridad.* – ***"It gives you security."***
>
> *No ves los sensores y al mismo tiempo te da tranquilidad y seguridad.* – ***"You do not see the sensors and at the same time it (the RADIO system) provides you tranquillity and security."***

The *sustainability dimension* regarding concerns about affordability or future needs were also pointed out by some participants:

> *Necesitaría saber cuánto cuesta.* – ***"I would need to know how much it costs."***
>
> *¿Si estoy enfermo me podrá ayudar dándome la medicación o ayudándome a caminar o levantarme?* – ***"If I get ill could it help me, give to me my medication or help me on transfers or walking?"***
>
> *... sí que necesitas dinero para tenerlo* – ***"…certainly you need money to have it"***

We cannot forget that the study is carried out in elderly volunteers with a preliminary positive attitude of input that could have contributed to a selection bias.

3.2 First integrated RADIO prototype at FZ premises

FZ's elderly participants evaluated RADIO prototype's usability and functionality as positive and beneficial while the system itself appears to be adequately user friendly. The users' positive approach for using the system frequently declares the positive emotions it provoked and of course their comprehension on the benefits it can bring to their daily living.

The complexity of the system presented a relative hesitation for the users mainly based on their first impressions and it is abruptly connected with their anticipated need for support from a technical person. These assumptions coincide with the feeling of the users that it is needed adequate time of training before feeling confident of using the system themselves.

Concerning obtrusiveness, overall the RADIO system has not been considered as obtrusive by the participants as they did not feel awkward having it around during the whole trial phase. Regarding their everyday routine, RADIO robot did not cause them any kind of obtrusive feelings. As far as it concerns physical and self-concept dimension of obtrusiveness, the responds of the users showed how comfortable they felt while interacting with the system, and they considered it also as not intrusive towards their home privacy and personal data. Again here some concerns were expressed connected also to the usability questionnaire, reflecting their low expectations as for their ability to use the system alone.

Their general impression also is that the system is not difficult to be used after some training and they are certainly keen on learning to use it. In addition, the use of the RADIO robot seems to significantly affect the everyday routine of the users in a way that helps the users retain their maximum possible autonomy something they consider of outmost importance for maintaining their quality of life.

4 DISCUSSION

The mean age of the participants in the pilot was 79, they had an average MMSE score of 24 and attended school for about 5 years. Two thirds were women.

Most of the participants were fully independent on ambulation and transfers, at least two instrumental activities of daily living were affected while half the sample reported some problems for daily decision making, mainly memory problems, but did not refer changes as compared to 90 days ago.

Overall, the assessment of usability and psycho-social impact of RADIO robot platform prototype performing the ADL recognition shows positive results. Indeed, with the exception of SUS, results from PIADS and ASQ suggest that the use of the system might positively impact quality of life of the end- users, thus indicating that the system is likely to be integrated into the home environment not compromising but improving daily living of elderly users.

Regarding obtrusiveness there was agreement among most participants about the physical unobtrusiveness of the robotic-domotic platform. On the other hand, it was not perceived as being obtrusive with respect to the self-concept, routine, home privacy or personal data dimensions. However, from a usability point of view there were more mixed opinions; some people found it easy to use meanwhile others found it more difficult. Again affordability seemed a potential problem in this group of participants.

Potential limitations to our results could be that the research assistant was helping participants across all scenarios, making usability easier and also an intrinsic positive attitude to technology of volunteers participating in the study (selection bias).

REFERENCES

[1] Folstein MF, Folstein SE, McHugh PR. «Mini-mental state». A practical method for grading the cognitive state of participants for the clinician. J Psychiatr Res. 1975;12(3):189-198

[2] Morris J, interRAI. interRAI Long-TermC Facilities (LTCF) assessment form and user's manual. Version 9.1 ed: Ann Arbor, MI: interRAI, 2010; 2010.

[3] Kehyayan V, Hirdes JP, Tyas SL, Stolee P. Residents' Self-Reported Quality of Life in Long-Term Care Facilities in Canada. Canadian journal on aging. La revue canadienne du vieillissement. 2015:1-16.

[4] Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist. 1969;9:179-186

[5] Brooke J. SUS: A "quick and dirty" usability scale. In: Jordan PW, Thomas B, Weerdmeester BA, McClelland IL (eds) Usability evaluation in industry. Taylor & Francis, London. 1996; pp 189–194

[6] Jutai J, Day H. Psychosocial Impact of Assistive Devices Scale (PIADS). Technology and Disability. 2004;14:107-111

[7] Lewis JR. An after-scenario questionnaire for usability studies: Psychometric Evaluation over three trials. SIGCHI Bull. 1991; 23(4):79-81

ANNEX 1 INTERRAI LTCF SECTION G

Activity of Daily Living	Indep-endent	Indep-endent, setup help only	Supervision	Limited assistance	Extensive assistance	Maximal assistance	Total dependence	Activity did not occur
Bathing	87.5%	0.0%	0.0%	0.0%	12.5%	0.0%	0.0%	0.0%
Personal hygiene	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dressing upper body	87.5%	12.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dressing lower body	75.0%	0.0%	0.0%	12.5%	0.0%	0.0%	0.0%	12.5%
Walking	87.5%	0.0%	12.5%	0.0%	0.0%	0.0%	0.0%	0.0%
Locomotion	87.5%	0.0%	12.5%	0.0%	0.0%	0.0%	0.0%	0.0%
Transfer toilet	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Toilet use	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bed mobility	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Eating	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

ANNEX 2 SECTION E INTERRAI LTCF

	Not present	Present not exhibited in last 3 days	Exhibited on 1-2 of last 3 days	Exhibited daily in the last 3 days
Made negative statements	75.0%	12.5%	0.0%	12.5%
Expressions including nonverbal of what appear to be unrealistic fears	100.0%	0.0%	0.0%	0.0%
Persistent anger with self or others	87.5%	12.5%	0.0%	0.0%
Repetitive health complaints	75.0%	0.0%	12.5%	12.5%
Repetitive anxious complaints	62.5%	0.0%	25.0%	12.5%
Sad, pained, or worried facial expressions	37.5%	0.0%	37.5%	25.0%
Crying, tearfulness	50.0%	0.0%	12.5%	37.5%
Recurrent statements that something terrible is about to happen	100.0%	0.0%	0.0%	0.0%
Withdrawal from activities of interest	50.0%	0.0%	25.0%	25.0%
Reduced social interactions	50.0%	12.5%	12.5%	25.0%
Expressions, including nonverbal, of lack of pleasure in life	62.5%	0.0%	37.5%	0.0%

ANNEX ·3 SECTION C INTERRAI LTCF

		%
Cognitive skills for daily decision making	Independent	50.0%
	Modified independence	50.0%
	Minimally impaired	0.0%
	Moderately impaired	0.0%
	Severely impaired	0.0%
	No discernable consciousness, coma	0.0%
Short term memory OK	Yes, memory Ok	62.5%
	Memory problem	37.5%
Long term memory OK	Yes, memory Ok	100.0%
	memory problem	0.0%
Procedural memory OK	Yes, memory Ok	87.5%
	memory problem	12.5%
Easily distracted	Behaviour not present	37.5%
	Behaviour present, consistent with usual functioning	62.5%
	Behaviour present, appears different from usual functioning	0.0%
Episodes of disorganized speech	Behaviour not present	75.0%
	Behaviour present, consistent with usual functioning	25.0%
	Behaviour present, appears different from usual functioning	0.0%
Mental function varies over the course of the day	Behaviour not present	62.5%
	Behaviour present, consistent with usual functioning	37.5%
	Behaviour present, appears different from usual functioning	0.0%
Acute change in mental status	No	100.0%
	Yes	0.0%
Change in decision making as compared to 90 days ago	Improved	0.0%
	No change	100.0%
	Declined	0.0%
	Uncertain	0.0%