The iStoppFalls Living Labs: Putting fall preventive technology in older adults' homes – lessons learned from our elderly co-creators

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Abstract
The primary aim of the "iStoppFalls living labs" was to evaluate an early prototype of the project's software and technology under real life conditions, i.e. during set-up and using a new ICT-based fall prevention & prediction system in older adults' homes. 27 participants from Cologne, 10 living lab users from Siegen, both Germany, and 4 participants from Sydney, Australia, participated in the "iStoppFalls living labs". Different test methodologies were applied, depending on the research focus and the respective system component under evaluation: diary, questionnaires, usability tests, interviews, workshops and focus groups. Detailed qualitative work with the participants of the "iStoppFalls living labs" was able to put all quantitative results from the pilot study into a specific context and thus revealed interesting insights into the attitudes and practices of older adults dealing with modern technology in their homes. The outcomes and implications of the living labs will guide the redesign process of the iStoppFalls technology and final demonstrator to be used in the upcoming randomized clinical trial (RCT) with a higher number of participants in different European countries and Australia. They emphasized again the utmost importance of end-user co-creation when putting ICT in older adults' homes.

1 Introduction

Demographic change and an ageing population in particular have elicited both interest and concern on the part of researchers, policy makers and governments in recent years. Older adults are living longer, and thus the challenge of implementing active health support and injury prevention technologies for older people has become a recognized issue in our health-care systems and society (Kannus et al., 2005).

Living Labs (LL) can provide a smart and self-adaptive ICT environment, which prevents and predicts falls in an unobtrusive manner, and helps ageing people to maintain their independent living by gaining health protection and wellbeing.

Based on participatory design, these LLs can be adapted to the needs and wishes of the participants by a cooperative process, thus making them co-creators. The primary aim of the "iStoppFalls living labs" was to evaluate an early prototype of the project's software and technology under real life conditions, i.e. during set-up and using a new ICT-based fall prevention and prediction system in older adults' homes.

2 iStoppFalls System

Aiming to provide technologies for older adults to support exercise and reduce fall risk, the iStoppFalls (Kinect-based) fall preventive exercise training program (Exergame) facilitates home-based preventative exercises, consisting of balance games and OTAGO exercises. Data is acquired in conjunction with unobtrusive sensing through the Senior Mobility Monitor (SMM) and biomechanical modeling. The SMM provides quantitative information on frequency, duration and type of daily activity and qualitative information on balance function and muscle power. These two sources of activity information are correlated by a knowledge-based system for fall prediction and prevention, which in turn yields sufficient data to perform trend analysis. The system is based on an interactive TV solution with gesture and voice control and a tablet, providing advanced human computer interaction.

3 Methods

Three LLs had been established in Australia and Germany. With a generic interest in an integrated approach, each of the partners applied their own research methods, study design and focus. The different approaches are presented and compared below. For an overview of all participants in the LLs, see Table 1.

Table 1 Overview of participants in the iStoppFalls Living Labs.

Study Location	Number of Participants	Gender (M:F)	Age (Years)	Dropouts[1]
Siegen	N = 12	5:7	72.7 ± 5.7	2
Cologne	N = 41	18:23	69.6 ± 1.9	14
Sydney	N = 5	1:4	73.2 ± 8.2	1
TOTAL	**N = 58**	**23:33**	**71.8 ± 5.7**	**17**

3.1 Living Lab Siegen

In the Siegen Living Lab, data was largely collected from face-to-face and telephone interviews (questions reg. experiences, problems, wishes), workshops (exploration of technical and design improvements), and focus group discussions (exchange of experiences). Additionally, participants

[1] Dropouts were mainly due to "too much technology", personal and health reasons.

completed usability tests (observation of users while conducting defined user scenarios) and questionnaires (concerning usability and acceptance), and kept a diary (documentation of feelings, routines etc. after each training). Methodologically, this qualitative bias is the defining feature of the LL in Siegen as compared to the more quantitative approaches in Cologne and Sydney.

3.2 Living Lab Cologne

The LL in Cologne employed two sequent methods surrounding the test itself: standardized medical and socio-demographic questionnaires and assessment of fall risk. It focused on long-term exercise and compliance facets by gaining information on 1) housing and education, 2) medical status, 3) (health-related) quality of life (SF-36, EQ-5D), 4) level of physical activity (German-PAQ50+) and 5) digital device ownership and usage. The fall risk was assessed utilizing the Physiological Profile Assessment (PPA) instrument (Lord et al., 2003), timed up and go (TUG) and the short physical performance battery (SPPB) (Guralnik et al., 1994), which were implemented both at pre- and post-test stages.

3.3 Living Lab Sydney

The primary focus of this LL was to determine the feasibility and exercise-related usability of the iStoppFalls Exergame and SMM. Feedback on each component was obtained by observation and completion of a set of questionnaires on the part of the participants. These standardized questionnaires measured and analysed disability (WHODAS II), quality of life (AQOL II), depression (Geriatric Depression Scale), PPA, TUG and sit-to-stand (STS) and cognitive abilities (ACE-III, Trails).

4 Results

Before the findings can be put into perspective with regard to the overall project and the benefits for the users (see Section 5), the individual results for each LL are presented below.

4.1 Living Lab Siegen

Participants of the Siegen Living Lab executed in total 1.599 exercise sessions, assessments and games.[2] Figure 2 shows a detailed view of activities per user in the Siegen LL. Qualitative and quantitative methods revealed important information regarding usability, accessibility and user experience for the system components and various input modes.

[2] This is surprising, considering the poor functionality and usability of the early system.

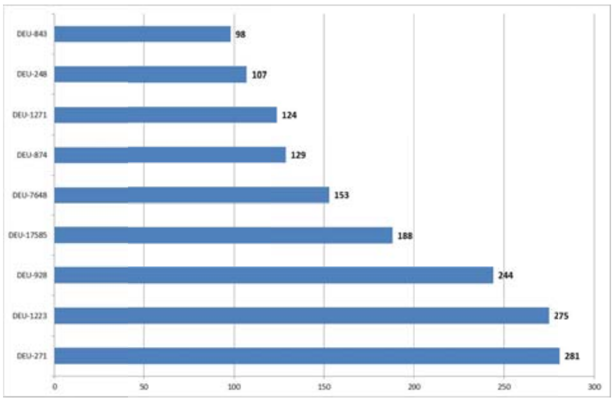

Figure 1. Number of assessment test and exercise sets (incl. 1 balance game, 3 OTAGO exercises and 3 assessment tests).

4.2 Living Lab Cologne

Unfortunately, technical problems and resulting low adherence to the program on user side prevented further evaluation of exercise components. We were not able to disclose any improvements in physical functions, such as strength or balance. The implications from the Cologne Living Lab included the impulse to add new balance games and exercises, new elements to the Fall Prediction Test, educational material and social media platform, and the I mportance of providing a prototype with a certain “readiness” for use regarding long-term adherence.

4.3 Living Lab Sydney

Despite initial technical problems, the participants in the Sydney Living Lab rated the system positively and commented that they would like to integrate the program into their everyday life. The participants gave a positive overall score for enjoyment and usability of the Exergame.
Furthermore, this LL provided important experience from outside the EU and feedback concerning the ambient assisted exercise program (AAEP), which includes the OTAGO exercises and the balance games, and the Fall Prediction Tests (FPT), which include sit-to-stand, balance and reaction tests.

5 Discussion

The implications of the various methodological approaches employed in the different LLs can be considered under two aspects: 1) the project view and 2) the end-users view.

From the project view, the results supported a re-design of the iStoppFalls prototype by the valuable insights gained from qualitative and quantitative data, e.g. concerning the participants' motivation.
Benefits for the users included that participants gained in confidence in relation to their use of ICT in general and improved self-esteem and social aspects: the participants were able to explain the technological details and ICT, and demonstrate their newly acquired knowledge to their friends and family. They furthermore increased awareness and the need to maintain and stay in good health while showing an interest in the subject of fall prevention.

6 Conclusion

Our overall study design has displayed that a close link of quantitative and qualitative approaches was most productive. It was least obstructive where the more qualitative parts served to facilitate an understanding of the purposes of the study and a tolerance for technical and other issues. The mixed methods approach was perceived to support a shared language amongst the researchers on one side, and the participants and users of this technology on the other side.
We wish to conduct a multicenter randomized clinical trial (N=160) with study centers in Germany, Spain and Australia. In parallel, the Siegen Living Lab will continue to retrieve additional qualitative data. Finally, a health-economics and exploitation analysis will be carried out by Philips based on the outcomes of the RCT.

References

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