iStoppFalls

Deliverable 1.5

End-User Requirements (Addendum)
Frail Elderly, Summary and Australian Data

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Abstract

This deliverable is an extension of the first Deliverable D1.5. We focus in this expansion only on very frail elderly whose age range from the late seventies to their early nineties and who are partly physically impaired due to mature life. Furthermore, results from additional end-user interviews (Germany & Australia) are presented and main outcomes of all interviews were synthesized and grouped for frail, active, and normal older adults.

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Executive summary

This addendum of the deliverable D1.5 provides an extended requirement analysis to focus on frail older adults with their perceptions and ideas on iTV systems facilitating fall-preventive exergaming at home. Naturally, older adults are reluctant against using ICT systems in their homes. On the other hand, fall preventive exercises need to be performed over a longer period of time to be effective. Thus, motivation and compliance plays a crucial role in this setting, whereby ICT systems may provide very good support, if they are fitted to the needs of the elderly end-users.

Despite frail older adults must not necessarily suffer from repeated fall experiences, it was decided to focus strictly on such frail older adults in this second wave of data collection. In order to assess requirements from this special group of end-users we carried out two additional structured interviews with seniors in Siegen (Germany) which were based on the interview schedule of the original deliverable D1.5 (End-user requirements analysis). In addition, a user-workshop with three frail older adults was implemented. In this session the frail older adults were able to test some already existing exergames (which were designed for younger people) and were introduced to tablets and different iTV interface configurations respectively.

Different implications for the planned iStoppFalls solutions (iTV, exergame, and SMM) were derived from first user tests as described above. In total it becomes evident during the workshops that our older adults participating in the workshops were considerably effective in using the (high-end) exergames we have provided. User interaction with these different system components should be based on gesture and voice control. Other I/O sources (mini-keyboard, etc.) might be used if intuitive control is not available in the respective home setting.

In particular, workshops affirmed the results from our first end-user testing period, that ICT-based exer-gaming carried out at home is well accepted by frail end-users (community-dwelling older adults). Future research with first "real iStoppFalls technology" is needed to provide a more detailed information and applied feed-back by the end-users.

Results from all empirical interviews of the iStoppFalls requirement analysis (22 interviews in Germany, Spain and Australia) affirmed that exergaming solutions for the domestic setting addresses a big need especially for the group of more fragile older adults. Furthermore, the interviews helped to gain a better understanding about the personal and social situation of these older adults and their special demands for a home-based fall preventive ICT application.

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Abbreviations

ICT	Information & Communication Technology
SMM	Senior Mobility Monitor
HCI	Human Computer Interaction
iTV	Interactive Television
AAL	Ambient Assisted Living
I/O	Input/Output

1   Introduction

With an EU population whose proportion of older people is constantly increasing, practices that are apt to effectively reduce fall-related injuries among older people have been in the focus of research for several years now. With regard to their efficiency, targeted exercise and gait training programmes, prevention and treatment of osteoporosis, environmental safety measures and multi-faceted programmes have proven to be most suitable when it comes to the reduction of fall incidence in older adults both dependently and independently living. In a nutshell, the measures taken and examined by the numerous studies read as follows. Various studies targeted multiple intervention falls prevention programmes (Haines et al.2004, Mahoney et al. 2007), looked at postural training in combination with a feedback protocol (Lajoie 2004), or cognitive behavioural learning in a small-group environment (Clemson et al.).

A focus lies on the improvement of functional performance, e.g. by means of short-term supervised stretching, balance, endurance, coordination, and strengthening exercises (e.g. Suzuki et al. 2004, Sykes et al. 2004 & Morgan et al. 2004). Here, the merits of exergames have increasingly earned attention over the course of the past five years (e.g. Ijisselsteijn et al. 2007, Gerling et al. 2010, Hsai-Hsuan Tsail et al. 2012) where several studies have researched their positive effects with regard to the overall well-being of older people, and more specific their physical health. Among these addressees of exergame training, the *frail elderly* mark a specific target group with very specialized needs and prerequisites. Fried et al. have developed a standardized definition for frailty in community-dwelling older adults, providing evidence that it is not synonymous with either comorbidity or disability, but comorbidity is an etiologic risk factor for, and disability is an outcome of, frailty (Fried et al. 2001, p. 146). With regard to the impact of exergames on frail elderly, Gerling et al. (2011a, 2011b) have summarized the scope of occurring problems, ranging from low-level controller issues and the inability to proceed through menu structures to complex effects of demanding in-game challenges and inadequate player feedback. Gerling et al. take these as proof of their argument for specifically designed games that are apt to provide a positive gaming experience.

Other researchers focused on the impact of health and nutrition factors, such as the impact of calcium intake or vitamin D supplementation (e.g. Dukas et al. 2004, Broe et al. 2007). Concluding, it can be summarized that the multi-facetedness of an approach is most relevant for its efficiency and success.

In order to assess requirements from particular frail older end-users we organized a second user-workshop with three participants carried out in Siegen, in which our senior users were able to test some already existing exergames (which were designed for younger people) and were introduced to tablets and different iTV interface configurations respectively. Furthermore, we carried out two more semi-structured interviews in Germany which followed the layout of all other interviews done for iStoppFalls (see D.1.5, first version).

Thus, this deliverable is an expansion of the first Deliverable D1.5. Just as in this first version of D.1.5, a requirement analysis is aimed which focuses on general perceptions and ideas of our end-users on possible iTV systems facilitating fall preventive exergaming at home. The results will be presented in chapter three. In contrast to this first deliverable we focus this time only on very 'frail' older adults whose age range from the late seventies to their early nineties and who are partly impaired by mature life. Following, the method of investigation and the research setting will be described in more detail. This report ends with a conclusion.

2   Methods

Within the deliverable D1.5 we are aiming to design solutions that will be usable and useful for the end-users.In order to do so, interviews were conducted and a user-workshop. In setting up both, interviews and workshops we orientated highly on the previous data collection. While interviews should help to understand daily practices of older adults, workshops were chosen to focus on older adults needs' in terms of information and communication, taking their abilities to interact with specific devices and technologies into account. This time the focus lay in particular on very frail older adults to see if there might be differences considering their needs and how they explore the social dimensions of technology use. This would allow to determinate how smart television technology and ICT can become as a resource for designing a fall prevention solutions for older adults. In the following, both approaches (interviews and workshop) are introduced in more detail.

2.1   Interviews

Since the research goal of this requirement analysis is to elicit practices, attitudes and reflections of the older adults in relation to a fall prevention technology at home, it was decided to conduct two more interviews with the so called more frail older adults in Germany, Siegen. Like the first, interviews were conducted in a semi-standardized procedure, i.e. structured by an interview grid, which has been developed according to the common and before mentioned core research themes. The main topics include the following items and can be reread in the mail deliverable D1.5 in more detail:

1) **General Information**
2) **Mobility and health**
3) **Fall related information**
4) **Media Consumption**
5) **Exergame and SMM**
6) **Privacy and Security**
7) **Miscellaneous**

The contact to the German interviewees was established via a good relationship form University Siegen to a senior accommodation management office, which provides accommodations to hospitals and older adults. The manager has very close relationship to the charterers of assisted and non-assisted accommodations. Thus, she was able to convey us older adults who are frail, but did not pass the exclusion criteria. For the interviews we addressed two women in non-assisted flats. Both were first asked by the accommodation manager if they would like to participate on interviews with the University of Siegen. After their ok was given, we obtained their telephone number and make an arrangement about an interview date.

Both interviews lasted about 90 minutes and were audiotaped like the others we conducted before. The interviews took place at the homes of the participants. It was an opportunity to observe the environment in which the participants lived, and allowed us as well to locate them socially in their environment.

During the interview sessions we started with a short explanation of the objectives of the project and the topics we wanted to discuss with them. We then asked permission to record the interview in order to be able to be more attentive, and to create a trustful atmosphere. Before the end of the interview we made sure that no questions remained on the interviewee's side. Next steps of the project were explained and expectations for next appointments. All participants were interested in participating in future studies of the project.

All three older ladies who took part in the workshop and the two elder female interview participants could be called rather fragile seniors. One lady was not able to walk without her wheeled walker. She also has more and more difficulties hearing and seeing. The other woman also has a pronounced visible impairment. The other participants have had quite a few falls, the last one a couple of weeks ago, which resulted in a hospital stay.

All three participants who took part on the workshop live alone in a complex in age-appropriate apartments that are connected to a nursing home/retirement home. The ladies from the interviews live still in their own houses. All participating ladies watch television, but had only little to no computer experience. The participants all watched TV, but up until now, didn't have any experience with computers.

2.2   Workshops

Beside the interviews we conducted a workshop with in particular frail older adults. As in the two earlier workshops preliminary scenarios of *iStoppFalls* were presented to the participants. The main goal of these workshops was to refine and extend these preliminary scenarios based on the needs and interests of the participants.

The workshop took place in Germany into an assisted living accommodation. Like in the interviews with the frail older adults we get the contact from the accommodation manager. Day and time were arranged with the three participants itself.

At the beginning of the workshop we introduced the *iStoppFalls* project and the aim of the workshop. The workshop itself was separated into two parts: the first part was a user centered session where we introduced tablet PCs to the participants. We showed them some functionalities and different applications. Afterwards we let the participants use the tablets without giving further instructions, and asked them to write some sentences in order to get feedback about the usability. Additionally, we presented the participants in this first session interface mockups of a possible main menu of the iTV application. Both Prototypes (A) and (B) included the items: *My training, My performance/ My results, My friends, Avoiding falls, Settings, News* (see figure 1).

Figure1. Main Menu of the iTV system (Prototypes A & B)

Both paper-based prototypes were discussed with the participants. We tried to find out with the help of a 'card sorting' method if the older adults understand the different functionalities and what they might expect to happen when clicking them. On each card is an action written like "seeing my profile" or "checking the profiles of my friends". The older adults had to put these cards on the paper-based mock-up of the iTV main menu.

By applying these usability techniques we wanted to find out more about the mental constructs of older adults and thus how such a menu could be designed to fit their ideas. By presenting them our concepts of an interface and especially during the card sorting the participants started to think about design implications and articulated their agreement with some concepts, criticized others, and made suggestions by their own.

The second workshop session focused on the user experience of playing exercise games. Using MS Kinect for about 90 minutes allows us to generate an understanding of older adults using a full body motion based exergame. Thus each participant plays about 30 minutes. All users had no prior experience with computer games which allows to study their first hand experiences. All play sessions were followed by a group discussion of about 15 minutes.

All three older ladies who took part in the workshop could be called rather fragile seniors. One lady was not able to walk without her wheeled walker. She also has more and more difficulties hearing and seeing. We will call her in the following P9. The other woman also has a pronounced visible impairment. She is named in the following P10. The third participant has had quite a few falls, the last one a couple of weeks ago, which resulted in a hospital stay and will be called P11.

All three participants who took part on the workshop live alone in a complex in age-appropriate apartments that are connected to a nursing home/retirement home. The ladies from the interviews live still in their own houses. All participating ladies watch television, but had only little to no computer experience. The participants all watched TV, but up until now, didn't have any experience with computers.

3   Results from usability workshops

The following section presents the results from the usability workshop with frail users playing MS Kinect based exergames. Results below comprise information on the 'Main Menu', 'Menu Interface', 'Integrating social contacts', 'Implications for the exergame', 'Implications for gesture control', 'Implications for voice control', and 'Implications for tablet-pc control'. These sections are assumed from the first deliverable D1.5.

3.1   ITV Menu and Interface

In the following results out of the usability workshop are presented, concerning the *'Main Menu'*, *'Menu Interface'* and *'Integrating social contacts'*.

Main Menu
During the workshops the participants were presented with the following suggestions for the structuring of the menu:
1. Start training
2. My performance/myresults[1]
3. My friends
4. Avoiding falls
5. News
6. Setting

Start training was very understandable for the participants: it meant access to the training games and programs such as running or gymnastics. The same wording should be used for the according menu item.
The menu item *my performance* or *my results* was self-explanatory for all workshop participants, too. They regarded it as displaying their evaluation and results. *'The results show that you've learned something, memorized something, etc.'*, said a participant (P11). The three participating ladies themselves felt this menu item was very important: *'When I start something, then I also want to have results, they interest me'* (P9). This shows that this content is very important for the motivation of the participants. If the menu item would be called *performance, results* or *progress* is was not important to the participants: *'Results, Progress, it's all the same'* (P9). They felt that all three terms described the underlying function. Thus, one of these three terms should be suggested.

For the participants the menu item *my friends* meant that they could play together with friends, acquaintances or family members who were with them at the time. This was something they could imagine themselves doing and would actually prefer this compared to playing alone: *'Yes, I can imagine playing with friends, because it would be more fun,'* said one participant P10.

The participants would also like an integration of a friends-list: *'If you do something together with your friends, then you're also more likely to talk about it later on and discuss the results. At least I can imagine that,'* another participant P11said. This means that writing messages or chatting would be something she could imagine doing under this menu item.

The item *avoiding falls* was also easy to understand for the participants: *'This item is there so that you stay on top of things. You should do something to exercise your brain a little,'* one lady (P9) said.

The integration of quizzes or short video clips into the iTV-application was also something they could imagine: *'I watch stuff like that on TV, about health and stuff. That interests me'* (P10).

News as a menu item was understood by one participant, as if she should write something or receive something, such as news from friends. The question if they would like to discuss each other's training results

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[1] On one paper prototype it said *performance*, on the other *results*.

and performance, the participants all answered with a clear 'yes'. *'The opinions of my friends do interest me,'* one participant P11said. Another woman P10 confirmed this, saying she likes to discuss such things.

Settings/Preferences as a menu item made sense to the workshop participants. They imagined that they could, for example, adjust the font size just like on the television set.

In conclusion, the labels of the menu items were easily understood and there were very few questions from the participants. There was no major functionality that should not be included according to the participants. Especially additional functions of the iTV application *Friends*, *Performance* and *Learning* were received positively.

Menu Interface

In the workshop the participants were presented with two different paper prototypes, to get feedback regarding the planned menu items: Both Prototypes (A) and (B) which are illustrated in Figure 1: 'Main Menu of iTV system' included the items: *My training, My performance/ My results, My friends, Avoiding falls, Settings, News*(see figure 1).

The participants agreed that prototype (A), with the four main navigation points, was the better option. *'It's definitely much better, because it's bigger'*, P 10 said. But the women with the eye-problems complained: *'When I try to read that, it's already getting blurry.'* Thus it became obvious, that it is very important that buttons and font are displayed as big as possible on the television screen and on the tablet-pc due to the decreasing eyesight of the elderly participants. Two of the workshop participants suffered from very poor eyesight. For them it is very important that the buttons not only are big enough but that they also use colors with a strong contrast.

The colors should also be very bright, such as red or blue, greys and other lighter colors shouldn't be used. *'It's really bad, when it's all just different shades of grey. When there's no contrast. I can see red, but grey and other colors like that not so much'*, participant P10 explained. *'It's no use. I'll give it a try. I can read ,training', because it's on a lighter background, but the other...'*, is another statement form the women with the very bad eye problems. Therefore it is also important that the words are in a dark color on a lighter background and not the other way around, even if the contrast is still the same. The question if symbols or pictures might be easier to be identified, was denied by all three ladies. Symbols were regarded as very complicated and possibly too difficult to recognize and understand.

Integrating social contacts

As already described in the section *menu items*, a scenario where several people train together in a public room or in one's living room, was something the older adults could imagine to do – much more than playing alone. P9 stated: *'I wouldn't do it for a long time alone. But with company, I would. It would motivate me, if someone would be there, doing it with me, so that you're not standing here alone, in front of the TV, doing those exercises. I think that's how you can quickly lose interest. It would be better, if someone did it with you – in the same room. I'd do the exercises with my sister-in-law. She also likes things like that.'*

Thus, companionship seems to be a big factor for this category of solitarily living older seniors. The integration of a friends-list was also well-received by the participants: *'If you do something together with friends, then you can imagine yourselves talking about it and the results afterwards. I can imagine that,'* one participant said.

3.2   Implications for the exergame

Following we will present design implications for the full-body motion based exergame played by frail older adults. These include suggestions for the application, to cope with frequently impairments of older adults, and for demonstrating the correct body positions.

Application suggestions

The following quotes from the workshop participants and interviewees should be taken into consideration when implementing the training exercises and games. Participants made positive statements about application suggestions as well as negative ones, what kind of applications would cause problems. Examples for the last group are: *'I can't bowl anymore. I can't bend down far enough anymore.' 'Dancing's not good for me because of my hip.' 'Dancing with my knee – that's not good.'* These quotations show that personal preferences and bodily abilities can differ so much that some suggested applications are refuses.

Positive statements about possible applications are the following applications: *'Yes, I like to run. I used to love dancing, too. Yes, I can walk pretty fast. I mean, I can still walk ok.' 'I like the music. That's my kind of music.' 'Well gymnastics would be the best.' 'Gymnastics exercises would be the most important.'* Or: *'It would be motivating if someone did the exercises with you, instead of just standing alone in front of the TV, doing those exercises. I think you'd lose interest pretty fast. It would be better if someone did it with you – in the same room.'* These positive statements about preferred applications show a wide variety of interest, which should be taken into account for design.

Taking impairments into consideration

As described above, handicaps such as poor eyesight and loss of hearing, need to be taken into consideration when designing the exergame. This was also confirmed by the following statements from the participants that were made while playing exergames with MS-Kinect: The woman P10 told us: *'Well, I'd have a problem now. I can't see very well. [...] I can only read large type with a magnifying glass. So that wouldn't be for me. [...] I can't read that at all (meaning the current monitor display). [...] I have glasses, but they're no use to me right now. I have a macula on both eyes and can barely read anything. Only with a magnifying glass.'* Thus, as mentioned above a clear design with big and contrastful elements is needed. During the play session where holes in an aquarium should be covered using hands or feet, so that the water cannot escape, the women complained that the holes were very small though and did not stand in a strong contrast to the rest of the background (*'I don't see any holes.' 'This is really hard for me, I'm sorry.'*) The eye problems handicapped this woman so much that must stop the game. She stated: *'It's not boring, but I can't see everything. Then it's sort of dumb. Everything's just blurry.'* Further the woman made the suggestion that: *'It could be, that it might help, if someone gave acoustic instructions.'* So in particular for older adults who have eye problems an acoustic support might be very helpful.

But that a better this means more clear and contrastful design enables the woman to play exercise games is illustrated by the following quotation: *'That it's green there, I can make that out. That it changes, too.'* In this application squares and triangles needed to be first balanced on a board with the arms, and thrown into a shoot on the left or the right.

Other than visual and acoustic impairments, like physical handicaps also need to be taken into account, as the following quotes from the participants emphasize: Thus, the lady with a rolled walker (P9) stated: *'I definitely need something to hold on to.'* Or: *'I can't get into a squatting position. 'I can't do anything on the floor.' 'I can't really lift my arms anymore.' 'Stretching out my arm is really tiring. Well, I don't think this is for me. I couldn't do this at home, because I live alone.'*

But also the woman (P10) who has no walking problems complained: *'The buttons for the foot are very far away.'* The woman (P11) stressed out that: *'Every couple of steps I have to stop because of my pain. I'm really terrified of going to the store. I need to stop so often on my way there and carrying stuff, I can't really do that anymore.'*

Increasing cognitive impairments also need to be regarded, which are illustrated by the following statements of the participants: *'Older people [...] might not be able to concentrate as well. I mean, I don't really have any problems yet, but that would really annoy me'* (P9). *'I have to concentrate really hard. [...] And if I didn't have to concentrate that hard, I'd be able to learn it really fast'* (P10). *'It's distracting, if, for example you're doing it for the first time and you constantly have to look at it. You really need to concentrate then. We're not 30 anymore'* (P9). These quotations show that also the content of the game itself should be clearly structured and simple in order to address older adults.

Demonstrating the correct body positions

For the participants it is very important that a virtual person (avatar) first demonstrate an exercise like a virtual trainer: *'I mean, if someone were to demonstrate right now. I thought this was something like that, so that you can memorize it and then copy the movements. But this is uninteresting for me, because I can't see everything. I'm the wrong person for this here!'* one participant said. *'If someone would demonstrate the exercise directly, that would be better,'* another participant stated. Although the woman with the eye problems did not see a strong benefit in an avatar, the other participants think that this would be helpful.

3.3   Implications for gesture and voice control

In the following the findings about implication for gesture and voice control will be presented. Thereby the issue of gesture control is partitioned into the subthemes of the avoidance of unnecessary movements, appropriate button size, and clear and concise instructions.

3.3.1   Gesture control

The participants had a very positive attitude towards a control via gestures and would prefer this to a control via a remote control. The following implications were noticed during the workshop and need to be taken into consideration.

Avoidance of unnecessary movements

The participants had big problems correctly choosing the buttons in the Kinect games that were used in the workshop. This was in part due to the fact, that it was required to stretch the arm a lot what causes problems for some participants: *'It's hard to fully stretch my arm,'* one participant complained. Another confirmed this, saying all joints were stiff.

Appropriate button size

Another difficulty with choosing the right button was that it was a double-navigation function. This means, that a button had to be selected first and then the hand has to touch a second button that popes up for a couple of seconds before the action can be executed. The frail participants had difficulties keeping their hands on the rather small buttons. They slipped off, before the action could be executed, so that they again had to put their hands on the button. Since people lose their sense of precision with age, the gesture control area for the iTV-application needs to be big enough, so that the older adults have no problems keeping their hand on the contact place for a certain period of time. The workshop participants also asked that only one button needs to be pushed, to do something.

No unnecessary function/ visual stimulation

It again became clear in this workshop, that most seniors did not want fancy add-ons or unnecessary extra functions. This was clearly shown in the comments: *'That's way too much, way too colorful'*, *'There's too much going on in that picture, there are way too many things on there'* and *'I would say the same. It's too much. You don't know where to look.'*

Giving clear and concise instructions

All older adults that were questioned had no previous experience with gesture or voice control. So it is important that this inexperience needs to be taken into consideration and that they receive exact and easily understandable instructions. It is generally important that older users receive hints and guidance regarding what is happening or what they should do, again and again. During the workshop this was done by the project staff. In the actual system, such hints need to be integrated in the application.

3.3.2   Voice control

Due to a technical pitfall, it wasn't possible to do any voice control during the workshop. But the participants would welcome such a control option. Especially for seniors with very poor eyesight it would be a great advantage.

3.4   Implications for the tablet-pc control

At least implications for the tablet-pc control are given. This concerns the front size, the avoidance of distractions and the exact replication of the TV screen.

Font size

The female participant with the macula-degeneration regarded it as a huge advantage being able to enlarge the fonts and the pictures. It is important for designing the tablet-pc application to take this into account.

Avoid distractions

For a self-explanatory and simple control, it is important that only the necessary information and functions are available. The older adults in the workshop were very sensitive to any sensory overload, as the following statements demonstrate: *'Then I'll be all confused later on', 'Everything's all mixed up', 'I have to concentrate on it first, before I can see anything.'*

Exact replication of the TV screen

An exact replication of the menu of the iTV system on the tablet-pc was something that all three participants could understand and imagine.

4   Additional results from end-user interviews

4.1   Australian interviews and additional frail users from Germany

The results from empirical interviews in Australia and with additional frail older German ladies re-affirmed that exergames for home based fall preventive training addresses a big need, especially for the more fragile older adults. Furthermore, the interviews helped to gain a better understanding of the social situation of the older adults and their special demands for a useful fall prevention application to be used at home.
The analysis of the interviews is presented in more detail in Appendix I & II.

4.2   Summary of all interviews from Spain, Australia and Germany

Appendix III summarizes all important outcomes from all interviews of all countries grouped for frail (n=8), active (n=5) and normal (n=9) older adults participating the interviews. Most participants were aged between 65-80 years, with some older participants up 90 years of age. All in all, slightly more women participated the interviews than men.

General Information: All participants live independently at home and are able to do most ADL activities, even the frail older adults. All active and normal older adults were well socially embedded, only the frail ones lived a bit isolated at home. Nevertheless, the frail older adults meet their family members on a regular basis.

Health and Mobility: Consequently, the so-called active older adults were active most of the days during the week, like exercising in a gym or regular walks outside. Most of the normal users take medications every day but try to be active during the week (walking, etc.). Most of the frail older adults already had surgeries and take medications regularly. Most of them feel unsteady and old, and try to be active from time to time.

Falls: Except of one, none of the active users have ever suffered any fall in their adulthood and have no fear of falling. Even most of the normal elderlies did never experience a fall, but most of them feel that they have a greater risk of falling. Not all of the frail elderlies have already experienced a fall, but some of them several times. All user groups were interested in information/education on falls.

Media Use: All participants are watching TV regularly. Interestingly, most of the active users were already familiar with using new media like computers, smartphones, etc. Even the normal elderlies have mobile phones and use computers from time to time. But most of the frail older adults do not like modern technology and new media.

Exergames and Activity Monitoring: Neither the active nor the normal and frail older adults have any experiences in using exergames, but some of the active participants know this technology from their grandchildren. Active participants would like to play cognitive games together with the physical exercises. Most users would favor gymnastics, virtual walks, and user-friendly exercise games as contents, especially music and dancing would engage older people to move and stay active. Most of the frail participants were interested in the SMM and associated activity monitoring.

Privacy and Security: Independent from grouping, all participants did not refuse to provide information about their health condition for the iStoppFalls computer system. They do not see any problem if the information given is used for medical purposes.

Other Aspects: All users think that the planned iStoppFalls system is very useful and that it can improve the quality of life of elderly people as well as prevent falls in the future. Neither prominent gender nor country-related effects could be demonstrated.

5   Conclusions

This deliverable is an expansion of the first Deliverable D1.5 and entailed a requirement analysis, which aimed to focus on general perceptions and ideas of our end-users on possible iTV systems facilitating fall preventive exergaming at home. In contrast to the first deliverable we focused in this expansion exeptional on very 'frail' older adults whose age range from the late seventies to their early nineties and who are partly impaired by mature life.

In order to assess requirements from particular frail older end-users we organized a second user-workshop with three participants carried out in Siegen, in which our senior users were able to test some already existing exergames (which were designed for younger people) and were introduced to tablets and different iTV interface configurations respectively. Furthermore, we carried out two more semi-structured interviews in Germany which followed the layout of all other interviews done for iStoppFalls (see D.1.5, first version).

The results from interviews with more frail older German ladies and those from Australia re-affirm that exergames for home based training addresses a big need, especially for more fragile older adults. Furthermore, the interviews helped to gain a better understanding about the overall social situation of older adults and special demands for a useful fall prevention application. Also, the analysis of the interviews is presented in more detail in the Appendix.

Although the small number of participants in workshops and interviews allows no significant important results, they allow nevertheless important insights into older adults lived reality. Thus the workshop with more frail older adults gives an idea that especially impaired vision plays a big role in an advanced age. This has to be strongly considered when designing the iTV system and exergame. Further, the strongest motivational factors to get the seniors to exercise continuously, seems to be feedback on one's own performance and playing as a group or with others. Especially additional functions of the iTV application like *Friends*, *Performance* and *Learning* were received positively form the more frail older adults.

Since the project is still in the stage of requirement analysis, a problem in the workshop was also that an existing and less senior-oriented' Kinect application (exergame) had to be used. This was rather intimidating for this category of relatively old seniors. Especially two of the three participants noted several times, that this wasn't suited for them, that they were too old. But especially these two participants led us to very detailed and very useful results.

In conclusion from the 22 interviews which were carried out for the iStoppFalls requirements analysis in Spain, Germany and Australia, it becomes apparent that there were no major country-related differences, and only small gender differences which were mainly related to the type of exercises which participants would like to do for fall prevention. Only the pre-defined groups (active, normal, frail) of participants showed significant differences in their attitudes, perceptions and social settings which are relevant for the design of the iStoppFalls system.

References

Broe, K. E., Chen, T. C., Weinberg, J., Bischoff-Ferrari, H. A., Holick, M. F., Kiel, D. P. (2007). A higher dose of vitamin d reduces the risk of falls in nursing home residents: a randomized, multiple-dose study. JAGS, 55, 234-239.

Clemson, L., Cumming, R. G., Kendig, H., Swann, M., Heard, R., Taylor, K. (2004). The effectiveness of a community-based program for reducing the incidence of falls in the elderly: a randomized trial. JAGS, 52, 1487-1494.

Dukas, L., Bischoff, H. A., Lindpaintner, L. S., et al. (2004). Alfacalcidol reduces the number of fallers in a community-dwelling elderly population with a minimum calcium intake of more than 500 mg daily. JAGS, 52, 230-236.

Fried, et.al., Frailty in Older Adults: Evidence for a Phenotype, in: Journal of Gerontology: MEDICAL SCIENCES, 2001, Vol. 56A, No. 3, M146–M156

Gerling, K., Schild, J., Masuch, M., Exergame Design for Elderly Users: The Case Study of SilverBalance, in: ACE '10, 17-NOV-2010, Taipei, Taiwan, pp. 66-69

Gerling, K., et.al., When Gaming is not Suitable for Everyone: Playtesting Wii Games with Frail Elderly, in: GAXID‶11, June 28, 2011, Bordeaux, France.

Gerling, K., et.al., Designing and Evaluating Digital Games for Frail Elderly Persons, in: Short presentation, ACE'2011 - Lisbon, Portugal

Haines, T. P., Bennell, K.L., Osborne, R. H., Hill, K. D. (2004). Effectiveness of targeted falls prevention programme in subacute hospital setting: randomised controlled trial. BMJ, 328, 676.

Ijsselsteijn, W., et.al., Digital Game Design for Elderly Users, in: *FuturePlay 2007*, November 15-17, 2007, Toronto, Canada, pp. 17-22

Lajoie, Y. (2004). Effect of computerized feedback postural training on posture and attentional demands in older adults. Aging-Clinical & Experimental Research, 16, 363- 368.

Mahoney, J. E., Shea, T. A., Przybelski, R., et al. (2007). Kenosha County Falls Prevention Study: A Randomized, Controlled Trial of an Intermediate-Intensity, Community-Based Multifactorial Falls Intervention. JAGS, 55, 489–498.

Morgan, R. O., Virnig, B. A., Duque, M., Abdel-Moty, E., Devito, C. A. (2004). Low- intensity exercise and reduction of the risk for falls among at-risk elders. Journals of Gerontology Series A-Biological Sciences & Medical Sciences, 59, 1062-1067.

Suzuki, T., Kim, H., Yoshida, H., Ishizaki, T. (2004). Randomized controlled trial of exercise intervention for the prevention of falls in community-dwelling elderly Japanese women. Journal of Bone & Mineral Metabolism, 22, 602-611.

Sykes, K., & Mun, L. W. (2004). Exercise training and fall-risk prevention for community- dwelling elders. American Journal of Recreation Therapy, 3, 36-42.

Tsai-Hsuan Tsai1, Hsien-Tsung Chang2, Gung-Shiung Huang2 and Chun-Chi Chang, WaterBall: The Exergaming Design for Rehabilitation of the Elderly, in: *Computer-Aided Design & Applications*, 9(4), 2012, 481-489

Appendix

Appendix I: Empirical data from Australia

GENERAL INFORMATION
Eight community dwelling older adults from Sydney were interviewed in April 2012. This section presents the information provided by the users interviewed about their personal and family data, dwelling, current health status and activities performed in their daily life.

Table 1 shows the general information of the "active elderly". Both users are people with a high level of activity – user 2 primarily through physical activity, user 7 through still being active professionally. These two users denoted their desire to remain active and engage in activities that keep them active both physically and mentally.

	User 2	User 7
Age (yrs)	78	78
Gender	Male	Female
Health condition	Very good	Good
Social situation	Lives with spouse and receives help for gardening and home maintenance. Participates in all kind of social event and club gatherings	Lives with spouse and requires no assistance. Participates in a variety of social events and gives guest lectures at university.
Dwelling	Unit - property. Home contains stairs, rugs, garden, hazards inside and outside, and large living room.	Unit - property. Home contains stairs, rugs, garden, large living room
ADL	No help needed for any ADL	No help needed for any ADL

Table 1. General information of "active elderly"

Table2 presents the general information of "normal elderly". All three users are in good health, but suffer from some medical conditions and are less active. Overall users were cognisant of the importance of being healthy to remain living independently for as long as possible. Users were motivated to remain healthy and all were active socially and involved in activities such as playing bridge regularly, involvement with sporting clubs and attendance at community forums such as the Probus club.

	User 5	User 6	User 8
Age	74	80	78
Gender	Female	Male	Male
Health condition	Good	Good	Good
Social situation	Lives with spouse and requires no assistance. Attends family and friend gatherings, visits other people and is part of a bridge club.	Lives with spouse and requires no assistance. Attends community events, visits other people and is part of a sports club.	Lives with spouse and requires no assistance. Attends community events, family and friend gatherings, visits other people.
Dwelling	Unit - property. Home contains rugs, and open space inside to do exercise.	Unit - property. Home contains rugs, hazards, and a large living room.	Unit - property. Home contains stairs, rugs, large living room
ADL	No help needed for any ADL	No help needed for any ADL	No help needed for any ADL

Table 2. General information of "normal elderly"

Table 3 shows the general information of "frail elderly". They have more severe pathologies and are less active; however, they do not need personal assistance. These users were concerned about their health and were somewhat frustrated that limitations in physical health could prevent them from participation in activities.

	User 1	User 3	User 4
Age	73	80	82
Gender	Female	Female	Male
Health condition	Moderate	Moderate	Good
Social situation	Lives with spouse and receives assistance for housework. Attends community events, family and friend gatherings, visits other people.	Lives with spouse and requires no assistance. Attends community events, family and friend gatherings, visits other people.	Lives with spouse and requires no assistance. Attends community events, family and friend gatherings, visits other people.
Dwelling	Unit - property. Home contains rug and open space to exercise.	Unit - property. Home contains a garden (with hazards) and open space for exercise	Unit - property. Home contains rugs and a large living room
ADL	No help needed for any ADL	No help needed for any ADL	No help needed for any ADL

Table 3. General information of "frail elderly"

ASPECTS RELATED TO MOBILITY AND HEALTH
In this section the aspects related to mobility and health are presented. These aspects refer to the objective health status and physical condition (diseases, taking medications, sports practice...).

Table 4 shows information related to mobility and health in "active elderly". We can observe that both users present good health and physical conditions. User 2 practices physical exercise every day, while user 7 is active through her busy lifestyle.

	User 2	User 7
Objective health condition (diseases, medication …)	Had bypass operation and cataract surgery in both eyes. Is on cardiovascular medication (nothing else)	Suffers from high blood pressure and high cholesterol. Is on cardiovascular medication (2 in total)
Physical activity (on average per week)	Swimming and walking for 45min 6x/week, golf 2x/week. Very active overall.	Goes for 1hr walk once a week and daily short walks. Plays tennis, busy lifestyle.
Pain	Very mild pain with no interference in ADL	Moderate pain with no interference in ADL
Sources of information on health care	GP and internet for details	Internet
Consider using email to communicate with GP	no	yes

Table 4. Mobility and health in "active elderly"

Table 5 shows information related to mobility and health in "normal elderly". All users do physical activity but they do not practice any sport. They try to maintain an active lifestyle and get informed on health issues.

	User 5	User 6	User 8
Objective health condition (diseases, medication …)	Two knee replacement and 1 hip replacement. No medications	hearing impairment, knee replacement, cataract surgery in both eyes, and is on 3 medications (cardiovascular and pyschotropic)	Hip replacement, no medications
Physical activity (on average per week)	Goes for daily walks of about 30min to 1hr. No other activities.	Goes for daily walks of about 30min. Lawn bowl 1x/ week.	Goes for a 30min walk twice a week, walks to shops etc. Overall not very active.
Pain	Mild pain with mild interference in ADL	Very mild pain with no interference in ADL	
Sources of information on health care	GP and chiropractor, occasionally internet	Mosty internet, GP if needed	GP
Consider using email to communicate with GP	yes	no	no

Table 5. Mobility and health in "normal elderly"

Table 6 shows information related to mobility and health in "frail elderly". User 1 and user 3 have a pathology that provokes them pain that interferes in ADL and physical activity. User 4 has a heart condition that stops him from doing certain exercises. However, they consider they are independent to carry out ADLs.

	User 1	User 3	User 4
Objective health condition (diseases, medication …)	Suffers from low back pain and osteoporosis. Is on 7 medications (sleeping tablet, antidepressants, psychotropic,cardiovascular) - no complications.	Suffers from high blood pressure and high cholesterol. Is on cardiovascular medication (others unsure)	has occasional fibrillation which is controlled by medication - no other medication. Had cataract surgery in both eyes
Physical activity (on average per week)	Exercise class (2x90min), walks (4x30min)	Goes for a 30min walk once a week. Not active	Goes for 1hr walk once a week and daily short walks. Not active.
Pain	Moderate pain with mild interference in ADL	Moderate pain with mild interference in ADL	no pain
Sources of information on health care	Internet, magazine, talking to peers, GP, pharmacist	GP and peers	peers and internet for details
Consider using email to communicate with GP	no	no	no

Table 6. Mobility and health in "frail elderly"

ASPECTS RELATED TO FALLS

In this section, the aspects related with falls and the circumstances that can increase the fear to fall are presented.

Table 7 shows information related to falls in "active elderly". Even though user 2 is very active, he suffered some serious falls, possibly through exposure. Both have good balance but are concerned about falls.

	User 2	User 7
Falls in past year	3 falls (1 fracture)	0
Risk factors	High levels of fear of falling, feels balance is good, no dizziness	Moderate fear of falling, occasional dizziness, good balance
Glasses	multifocals but not needed when outside	no
Interest in receiving information on falls prevention	Yes	yes if convenient
Preferred format	personal, internet	booklet, TV, internet

Table 7. Falls in "active elderly"

Table 8 shows information related to falls in "normal elderly". Only one had a fall, but they would all like to receive information about falls prevention.

	User 5	User 6	User 8
Falls in past year	0	1 fall, no injury	0
Risk factors	Low levels of fear, feels balance is good, no dizziness	Moderate fear of falling, occasional dizziness, fair balance	Low fear of falling, no dizziness, good balance
Glasses	no	no	no
Interest in receiving information on falls prevention	Yes, especially for exercises	Certainly	possibly, would consider it
Preferred format	internet	booklet, internet	booklet

Table 8. Falls in "normal adults"

Table 9 shows information related to falls in "frail elderly". Only user 1 suffered fall in the past year, user 4 has good balance but is at great risk of syncope related falls.

	User 1	User 3	User 4
Falls in past year	2 falls with injuries	0	0
Risk factors	High levels of fear of falling, feels balance is fair, no dizziness	Moderate levels of fear of falling, feels balance is poor, feels dizzy occasionally	No fear, feels balance is good.
Glasses	multifocals	MD	no
Interest in receiving information on falls prevention	Yes	yes, providing not too time consuming and at home	Yes
Preferred format	booklet	personal, TV	booklet, internet

Table 9. Falls in "frail elderly"

ASPECTS RELATED TO THE USE OF MEDIA.
In this section the aspects related to the use of media are presented, especially TV, radio, press and more complex media, such as smart phones, computers, internet, tablets.

Table 10 shows information related to the use of media by "active elderly". Both users keep informed by both traditional media such as TV, radio and press and more modern media such as the internet.

	User 2	User 7
Use of media (type)	TV and newspaper	Internet and newspaper
Frequency of media use	Daily (TV, computer, internet, email), never (skype)	Daily (TV, computer, internet, email), Weekly (skype)
Problems with the use of media	no problems	the keyboard on the ipad is too sensitive, but overall no problems
Circumstances that facilitate use of media	simple instructions, straight language, modern english	no problems but sees a future in more simple and clearer systems
Trying new devices	yes	yes

Table 10. Use of media by "active elderly"

Table 11 shows information related to the use of media by "normal elderly". They mainly keep informed by traditional media such as TV, radio and press but they do not use more modern media such as the internet for looking up health-related issues.

	User 5	User 6	User 8
Use of media (type)	TV, newspaper. Internet for hobbies	TV and newspaper	Internet, radio and newspaper
Frequency of media use	Daily (TV, computer, internet), Weekly (email), never (skype)	Daily (TV, computer, internet, email), Monthly (skype)	Daily (TV, computer, internet, email), Weekly (skype)
Problems with the use of media	hard overall but no specific problems	computer illiterate but no specific problens	no problems
Circumstances that facilitate use of media	user-friendliness	instruction manuals too much redundant info	good as is
Trying new devices	no	no	no

Table 11. Use of media by "normal elderly"

Table 12 shows information related to the use of media by "frail elderly". User 3 and 4 keep informed by traditional media such as TV, radio and press, but they do not use more modern media such as the internet frequently. User 1 uses the internet frequently to look up health related issues.

	User 1	User 3	User 4
Use of media (type)	Internet, newspaper, tv	TV, newspaper, books	TV or magazines
Frequency of media use	Daily (TV, computer, internet, email), never (skype)	Daily (TV), Weekly (computer, email), never (internet, skype)	Daily (TV, computer, internet, email), never (skype)
Problems with the use of media	eyes get tired, font can be enlarged on monitor	doesn't like watching screen	no problems but no experience
Circumstances that facilitate use of media	practicing	layman language, include basic knowledge in tutorials	remote controls should be simplified (necessary buttons separate)
Trying new devices	no	no	yes

Table 12. Use of media by "frail elderly"

ASSESSMENT OF THE USE OF THE EXERGAME & MOBILITY MONITOR.

In this section, the results obtained from the assessment of use of the mobility monitor are presented; particularly those related to the use of consoles and the SMM.

Table 13 shows information related to the use of videogames and the mobility monitor by the "active elderly". Both users feel it has to be enjoyable. User 2 in particular noted that for older adults, games must be easy to use, be uncomplicated and simple. Issues surrounding the SMM included design components, i.e. the SMM was too bulky or unattractive to wear

	User 2	User 7
Previous knowledge and use of videogames	no	likes Wii, and knows of Xbox.
feasibility of videogames for oldies	It has to be simple, not complicated, enjoyable. People would use it if it helps	Definitely because you can do it in your own home. Using a videogame would make exercises more fun and entertaining.
Suggestions videogames	training of a couple of hours in using the system and a follow-through sheet with clear diagrams	have exercises in sitting down position for people concerned about balance
Contexts of use	motivation to do it with someone (wife or peers) but not with grandchildren, they would not be interested. No interest in competition	rather on my own, other people will be at different levels
Room	living room	study or sitting room
PERS previous knowledge	yes, but feels they are redundant - people don't use them, never heard of SMM	yes, never heard of SMM, having them automated is great
Design SMM	too obtrusive, wear it under clothes	too proud now to wear this, too bulky
Continuous tracking	ok if it has good feedback, not if it is for marketing purposes	ok
appreciation of eHealth system	possibly, but some issues with privacy	fun!
personal feedback through TV	invaluable, such a system would confront people if they didn't do exercise	very interested
Suggestions eHealth	repetitive, no continuous changing of interface	compete against self
use of eHealth	yes, some people might prefer this system because they are shy to exercise in front of others or asking questions	very much but would like to see it first

Table 13. Assessment of the mobility monitor by "active elderly"

Table 14 shows information related to the use of videogames and the mobility monitor by the "normal elderly". All users are happy to play videogames but have some level of concern regarding complications or supervision. The issue of difficulty in using a gaming system is reflected in most of the groups. Games will need to be easy to use, easy to set up and start, and be pitched at a level suitable for the player. Most users report that they would prefer to play games on their own rather than in competition with other people.

	User 5	User 6	User 8
Previous knowledge and use of videogames	daughter has Wii	no	grandchildren have xbox
feasibility of videogames for oldies	yes, but it would have to have a purpose like improving balance, joint flexibility. The person doing it would have to be mindful of all the problems they have cognitive ability would be important	yes	yes, would like to play activities like golf coz never had time to learn.
Suggestions videogames	a warning saying when not suitable for people with certain conditions	no	some people might need supervision, something that motivates people to keep going (e.g. problem solving tasks)
Contexts of use	rather on my own, exercise is too individual, virtual exercise class would be fine	rather on my own, no competition, happy to play with others virtually	rather on my own, grandchildren are too old to play
Room	study	living room	living room
PERS previous knowledge	yes, never heard of SMM	yes, never heard of SMM	no, never heard of SMM
Design SMM	ok, unless if I'm going out to an event	it looks odd as necklace but non-issue	would wear it for trial or if someone said I needed it
Continuous tracking	OK	sounds great!	ok, but camera only for duration of the game
appreciation of eHealth system	only if additional, personal contact is important	no, no additional value	no, such systems are too addictive
personal feedback through TV	ok	ok	interested
Suggestions eHealth		information and feedback	especially for people living on their own
use of eHealth	yes	yes	acceptable as prompt to exercise

Table 15. Assessment of the mobility monitor by "normal elderly"

Table 16 shows information related to the use of videogames and the mobility monitor by the "frail elderly". The frail users were typically not very enthusiastic about long term use of the SMM but did observe that the idea of having a fall detection system would be acceptable to them. None of the frail users were too impressed by the concept of an eHealth system but it is possible that they did not fully understand the concept. Personal contact with clinicians was preferred.

	User 1	User 3	User 4
Previous knowledge and use of videogames	son uses it	no	no
feasibility of videogames for oldies	there is potential	it would depend on their background and physical abilities	ball games would be my preference, but not sure if I would use. I would be happy to give it a try.
Suggestions videogames	easier to set it up and more user-friendly to use	training at people's own pace, no stress	music would engage people
Contexts of use	opportunity doing exercise with husband, doing exercise when bad weather, something to entertain grandchild	rather do it my own, other people might be critical	rather by myself, would not like to compete
Room	living room	sitting room	separate room
PERS previous knowledge	yes, wonderful idea for people who need them, never heard of SMM	yes, I encourage people to get one, never heard of SMM	Yes, never heard of SMM
Design SMM	necklace too noticeable, a clip would be better	looks too clinical, wouldn't wear it outside of clothing, should be 'disguised' as something more interesting	ok
Continuous tracking	ok for short period, 24-48 hours	ok but not wearing a pendant like that every day	ok for research study, but it would have to look more attractive on long run
appreciation of eHealth system	too intruding, would like to be instigator, clinicians have no time for this	not sure	only if additional, personal contact is important
personal feedback through TV	ok	interesting, it would be good to be told how to improve fitness	is that really feasible? Would be good
use of eHealth	would use it, if information can be checked at own time	interesting concept, would have to see	definitely

Table 16. Assessment of the mobility monitor in "frail elderly"

ASPECTS RELATED TO PRIVACY AND DATA SECURITY.

This section presents the aspects related to privacy and data security for "active users" (table 17), "normal users (table 18) and "frail users" (table 19).All users are willing to provide information about their health condition but only for medical purposes. None saw the need to disclose this information to friends. Interestingly, few users considered personal information other than health in their initial response. When prompted, concerns around storage of financial data was reported as important. All users were happy with the idea of creating a profile of physical activity.

	User 2	User 7
Disclosing personal information	no concerns, as long as people won't interfere in life	no concerns for people to see, but would worry if insurance company would use information to make premium go up
Medical analyses	no concerns	depends on who's making the diagnosis, it would have to be backed up with personal contact
Creating profile	very happy	very useful, would like to see how activity patterns change as getting older, or if sitting down too much
Sharing data with others	GP, nobody else	GP, not family, not friends

Table 17. Privacy and data security in Active elderly

	User 5	User 6	User 8
Disclosing personal information	no concerns	no concerns if for health monitoring	no concerns but would not like to have locations to be stored.
Medical analyses	no concerns	no concerns	ok, but would like control over who accesses information
Creating profile	ok	ok	fair enough for experimental purposes
Sharing data with others	GP, family, not friends	GP, family, not friends	GP, not family, not friends

Table 18. Privacy and data security in normal elderly

	User 1	User 3	User 4
Disclosing personal information	no concerns overall, but would prefer to keep certain information confidential	no concerns if just health	no concerns if it is for significant use and only health
Medical analyses	ok, if professional	who would get the diagnosis, would it come back to me as well, overall no concerns	would like to have a systems that monitors heart rate continuously because heart fibrillation problem
Creating profile	ok	interesting	ok
Sharing data with others	No need - GP wouldn't have the time, daughter would ring me	GP, would rather tell family than share automatically, not friends	GP, family, not friends

Table 19. Privacy and data security in frail elderly

All users were willing to participate in future trials. All were interested in the use of videogame technology to promote physical activity and would be willing to participate in trails. No users reported that an exercise-based videogame system or health monitoring technology would be inconvenient. Many were interested to participate in a 6 month trial and then subsequently continue to use the system. All were intrigued by the possibilities of home-based monitoring of personally specific fall-related and other health information.

Appendix II: Empirical data from frail elderlies in Germany (addendum)

GENERAL INFORMATION

This section presents the information provided by the additional frail users interviewed about their personal and family data, dwelling, current health status and activities performed in their daily life. Table 21 shows the general information of "frail elderly". All three interviewees have some severe pathology that hampers the practice of physical activity regularly; however, they do not need personal assistance. Both have an active social life.

GENERAL INFORMATION (GERMANY)	
FRAIL elderly	**Health condition** ✓ User 5 had a hip surgery, but feels better than before the surgery. She feels that she is in a good health condition. When she goes out of the house, she takes a walking-stick umbrella with her to preserve her hips. Inside the house she holds on to the banister rail to walk safely. ✓ User 7 had a herniated disc. She had 12 surgeries. Troubles with her back, thyroid, upper abdomen, gall stones etc. Has recovered after the surgery. Feels shaky. When she goes out of the house, she takes a walking-stick umbrella with her. She has a wheeled walker. ✓ User 8 can only go short distances with a cane, without a stick, she feels unsafe. She can barely move her right leg because it is almost deaf. Inside the house she holds on to the banister rail to walk safely. She had 2 heart surgeries and has to visit to the doctor for every 6 months. User 8 is quickly exhausted. She has never played sports because she was too busy. **Socialsituation** ✓ User 5 does not participate in a weekly or monthly activity or meeting. Before her hip surgery she went weekly to a gymnastics course. Sometimes she does bus tours with other seniors. Once in two years she goes for a medical cure. She is in close contact to her family, but she does not get on well with her neighbours, because in her opinion they are jealous of her big estate. She maintains old contacts, but she doesn't like to travel a lot. User 5 has got two young friends (two brothers), who help her frequently with heavy work in the house or garden like paperhanging. ✓ User 7is in contact with two cousins from the town and has 7friends. She visits sewing course for 30 years. Once a week she visited a gymnastic class, but after the herniated disc the doctor adviced her to stop because she is to unsteady on her feet. Recently she exercises alone at home. Recently she has been making exercises alone at home that were prescribed by a doctor. She has a nephew who takes care of organizational matters. ✓ User 8 feels alone, get no medical assistance. She can rely on her children. Go once a week to play cards. She wants more offerings for older people like community events. **Dwelling** ✓ User 5 owns a 630 m² big estate with a 125 m² living space, which extends over three floors. Additionally the house is located on a slope. So User 5 lives with a lot of architectural barriers like stairs or steep paths. She lives there alone, but she feels very comfortable in here house.

	GENERAL INFORMATION (GERMANY)
	✓ Since her husband died 2.5 years ago user 7lives alone in a rented apartment in the city. The apartment has a lift access, disabled bathroom and is designed especially for older people. She feels very comfortable in there. ✓ User 8livingalonefor 2.5 years in a 62square meter apartment. She doesn´t feel comfortable in her apartment because the house is scary and very quiet. **Activities performed in daily living** ✓ User 5 does the household and the garden, but not everything in the garden like risky work at the slope. She goes shopping on foot. She walks at least one hour per day. She makes gymnastics every day for 20 minutes on her own. ✓ User 7 mostly travels by bus, only rarely by foot because it is too uncertain. ✓ When the weather is good user 8 takes a walk for 20/30 minutes. She only walks short distances by foot. But she tries to exercise regularly e.g. climbing stairs. Sometimes she makes exercises on the chair that she has learned in the rehab or watched on the TV.

Table 21. General information of "frail elderly"

ASPECTS RELATED TO MOBILITY AND HEALTH

In this section the aspects related to mobility and health are presented. These aspects refer to the subjective perception of health status and objective physical condition (diseases, taking medications, sports practice...). Table 22 shows information related to mobility and health in "frail elderly". Both users have a pathology that provokes them pain that hampers them practicing any physical activity. However, they consider they are independent to carry out ADL's.

	MOBILITY AND HEALTH (GERMANY)
FRAIL elderly	**Objective health condition (diseases, medication …)** ✓ User 5 takes pills and ointment for her hip pain, but not regularly. Furthermore she takes hormone pills because of an anomaly, since otherwise she would get a headache and nervousness. These pills have no side effects. ✓ User 8 takes pills for her low and high blood pressure, because it varies all the time. **Physical activity** ✓ Except working in the house and garden, User 5 regularly makes her gymnastics, which were shown to her in the cure. Before her hip surgery she went weekly to a gymnastics course. She goes for a walk every day for at least one hour. ✓ Before the herniated disc, user 5 went every dayto the gym. Now she is too shaky. She always takes a bus uses a walking stick or umbrella to walk. ✓ User 8hascoordinationproblems. She can slowly dress up on her own. She gets support for the house work, can only wipe dust. She just walks with a walking stick. **Subjective health condition (health perception)** ✓ User 5 feels after her hip surgery much better than before ("I'm back again one hundred percent."). She sees the garden work at the slope as a risk factor for her. She wants to boost her mobility of herself, which was particularly strongly needed after her

MOBILITY AND HEALTH (GERMANY)	
	surgery. She was afraid of her surgery, but she almost reached her old health condition. She feels that she is in a good health condition, but she is aware that this is getting worse with increasing age. She wants to provide for herself as long as possible.
	✓ User 7 feels very unsteady on his feet. She can only bend down badly and describes herself as very old. Has a lot of energy and will to live, but when she is alone it decreases.
	✓ User 8 likes to move, but is quickly out of breath. Gymnastics does not help and the doctors say that it is not getting better. Motivation for the walks is that she is not stuck at home.
	Sources of information on health care
	✓ User 5 has no particular source of health information. Sometimes she reads different magazines or watches something on TV. She doesn't catch up on something specific.
	✓ User 7 is informed about general health information. She reads newspapers, watches TV and also asks the doctor.
	✓ User 8 reads newspapers, but not about health, because she only gets upset about it and she forgets everything anyway.

Table 22.Mobility and health in "frail elderly"

ASPECTS RELATED TO FALLS

In this section, the aspects related with falls and the circumstances that can increase the fear to fall are presented. Table 23 shows information related to falls in "frail elderly". Both users are very afraid of suffering falls due to the pathologies they have. Consequently, they avoid all the risk factor they can, such as climbing stairs, walking on rough pavements.

FALLS (GERMANY)	
FRAIL elderly	**Falls**
	✓ User 5 fell once as she was a child and has got a crooked arm since then. She has not done yet any fall experiences in her higher age.
	✓ User 7fallsfrequently. She has already fallen 3 times in her apartment. Her first fall experience was already in childhood. So far, there were no serious consequences like broken bones.
	✓ User 8 has fallen once because of a heart problem and once just for no reason, because her legs were wobbly.
	Riskfactors
	✓ User 5 avoids performing activities that imply more probabilities of falling down like working on a slope. When she goes out of the house, she takes a walking-stick umbrella with her to preserve her hips. As she is a little bit afraid of falling, she holds on to the railing inside the house and outside at the slope paths to walk safely.
	✓ User 7 is not afraid to fall. When she is not feeling well, she takes an emergency bracelet and she feels safer.
	✓ User 8 is not afraid to fall, because she has a walking stick. She has an emergency button for help at home.
	Interest in receiving information on falls prevention
	✓ She would be grateful for tips and information how to better behave to avoid falls, for example if there are special help devices for ice and snow. She could imagine such information in the form of quizzes because these are her

FALLS (GERMANY)	
	passion.
	✓ User 7hasnot done any preventions with falls, because in her opinion she is too old. She would rather like to be fitter and is interested in information.
	✓ User 8 doesn´t want to get health information, because of her bad memory. Health information makes her up set.

Table 23. Falls in "frail elderly"

ASPECTS RELATED TO THE USE OF MEDIA.

In this section the aspects related to the use of media are presented, especially TV, radio, press and more complex media, such as smart phones, computers, internet, tablets.
Table 24 shows information related to the use of media by "frail elderly". Both users keep informed by traditional media such as TV, radio and press, but they do not use more modern media such as the internet because they cannot use a computer. Both users are reluctant to use new technologies.

USE OF MEDIA (GERMANY)	
FRAIL elderly	**Frequency and use of media**
	✓ User 5 watches TV in the morning and the evening for the weather information, news and crime thrillers. Furthermore she reads magazines.
	✓ User 7watches TV in the evening by herself, reads newspapers, listens to the radio and has no cell phone, just a phone.
	✓ User 8´s TV is always on, so that she hears voices. Has a radio, but she doesn´t use it. She uses her phone only for making phone calls. She buys newspaper just for crossword puzzles and Sudoku. In the past she had worked at the computer, she doesn´t dare to use it anymore.
	Problems with the use of media
	✓ User 5 does not have a computer and an internet access, because she doesn't see any advantage in it. At the end of her career, she made some experiences with the computer, but she didn't feel any joy in its use. She still can see almost everything without glasses and she still can also hear well. She cannot do much with technical terms like virtual, controller, e-mail, teletext, etc.
	✓ User 7 is afraid of using cell phones. A good introduction would help her. She has no problems with the use of television, is not afraid of technology. She is glad she does not have a PC.
	✓ User 8 doesn´t like to learn anymore. She has no problems with the use of media, but is afraid to break the devices.
	Circumstances that would facilitate the use of media
	✓ User 5 would find a gesture control great. She wants to have only a few menu items. She has not much imagination how one might design such a game for seniors. Easier technical terms would facilitate the use of media for seniors.
	✓ User 7 needs a good introduction for the device. She would not want to ask how the device works, but instead she wants to manage it herself.
	✓ User 8 thinks that gestures and voice commands make sense, but is not interested to learn it anymore.

Table24. Use of media by "frail elderly"

ASSESSMENT OF THE USE OF THE EXERGAME &MOBILITY MONITOR.

In this section, the results obtained from the assessment of use of the mobility monitor are presented; particularly those related to the use of consoles and the SMM.

Table 25 shows information related to the use of the mobility monitor by the "frail elderly". One of the users knows about consoles through his relatives, but user 6 has never seen a console. If video games were better suited to the needs of this collective and easier they think they would maybe use them.

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR (GERMANY)	
FRAIL elderly	**Previous knowledge** ✓ User 5 knows about these types of consoles through his grandchildren but has no experience in playing them. **Use of video games** ✓ User 5 and user 7 have never played video games. ✓ Sometimes user 8playsgameson a laptopofher grandchildren. **Suggestions** ✓ User 5 would play gymnastics games any time. She can very well imagine virtual walks in different cities like Düsseldorf or Frankfurt. Sports such as skiing or surfing would have been very interesting for her in the past (she likes water sports), but there was no possibility to practice them during or after the war. She doesn't believe that she would still learn such sports today, but maybe in a virtual and easier manner. She can also imagine to integrate hiking and stairs climbing in such games. She wouldn't see small text information as bothersome, when they would appear during a crime thriller. But when it is an exercise reminder, she first would finish her crime thriller. A chat function would be too complicated for her. ✓ User7 would prefer to do exercises at home alone than in the group. Is motivated to take exercise, if they help her to get fitter. She is afraid that the exercises are too fast and she is too old. ✓ User 8 doesn´t like chat feature, because it is too complicated. She prefers the phone to communicate and they prefer the phone, if she wants to communicate. **Context of use** ✓ User 5 prefers to play in the winter, when she cannot work in the garden and spends much time in the house. The ideal context for her is to use the console at home, in the living room or bedroom, where she has TV devices. ✓ User 7 could imagine watching TV to do exercises, but only if she feels able to do it and if it is not too fast. ✓ User 8 likes to do exercises in front of the television on the floor or on the chair, if they are suitable for her.

Table 25.Assessment of the mobility monitor in "frail elderly"

ASPECTS RELATED TO PRIVACY AND DATA SECURITY.

This section presents the aspects related to privacy and data security.
All users are willing to provide information about their health condition but only for medical purposes (see table 26).

PRIVACY AND DATA SECURITY (GERMANY)	
FRAIL elderly	✓ None of the users refuses to provide information abouttheir health condition for the computer system. ✓ They do not see any problem if the information given is used for medical purposes. ✓ All users would accept that their movements were continuously monitored and would not mind carrying the necklace at home. ✓ They like the idea of customizing their activities and movements. ✓ They would like to share this information with family and health professionals.

Table 26. Privacy and data security

Appendix III: Summary of all interviews from Spain, Australia and Germany

This section summarizes most important information (main similarities and differences between groups) from all users interviewed from Germany, Australia and Spain. Interviews were conducted with 22 people in total. There were 5 active elderly, 9 normal elderly and 8 frail elderly as related to predefined groups (normal, frail, and active).

GENERAL INFORMATION (all participants, N=22)

GENERAL INFORMATION	
ACTIVE elderly	**Health condition** ✓ None of them required personal assistance or supervision for their activities of daily living (ADLs) ✓ All of them are active and have good health condition **Social situation** ✓ Participate in social events and club gathering ✓ Most of them have contact with their family ✓ Socialize with friend and peers **Dwelling** ✓ Users live in their own house or spacious flat ✓ Some of them have a garden and some architectural barriers ✓ Most of them have open space inside to do exercise **Activities performed in daily living / ADL** ✓ No help needed for any ADL ✓ Users who live alone, they manage the household by themselves ✓ Users who live with spouse do household together ✓ Most of them practice exercise or goes for a walk regularly

Table 27. General information of "active elderly"

GENERAL INFORMATION	
NORMAL elderly	**Health condition** ✓ None of them required personal assistance of supervision for the performance of ADLs ✓ Users feel that their body does not function the same way during some activities, but in general, they are in good health conditions **Social situation** ✓ Users go to a social centre for elderly. Meets regularly friends, peers and family to maintain social contact. Enjoy meeting new people. ✓ Users like to travel and have hobbies and other activities **Dwelling** ✓ Except of one user have all of them own house with no architectural barriers

GENERAL INFORMATION	
	✓ Most of them have open space inside to do exercise **Activities performed in daily living / ADL** ✓ No help needed for any ADL ✓ Users do the household, makes the garden, the cooking ✓ Most of them enjoy walking and meeting up with friends or family

Table 28. General information of "normal elderly"

GENERAL INFORMATION	
FRAIL elderly	**Health condition** ✓ Health condition is between moderate and good ✓ Most of them had a surgery before and feel restrict in activities. Take a walking stick with them **Social situation** ✓ Some users have no regularly activity or meeting and some users attend community events or social center for retired ✓ All of them are in contact to their family and friends, meet other people **Dwelling** ✓ There are no coincidences in the living situation. The users live in different housing situation. **Activities performed in daily living / ADL** ✓ Users do the household by their own, but some of them need support in the household or in the garden ✓ Most of them go for a walk or try to make gymnastics so much as possible

Table 29. General information of "frail elderly"

ASPECTS RELATED TO MOBILITY AND HEALTH (all participants, N=22)

MOBILITY AND HEALTH	
ACTIVE elderly	**Objective health condition (diseases, medication …)** ✓ Users have small health problems ✓ Most of them take medication regularly and have mild pain **Physical activity** ✓ All of them go for a walk or to the gym regularly ✓ Users are very active overall **Subjective health condition (health perception)** ✓ Users feel good for their age, do not complain about their diseases and have positive attitude **Sources of information on health care** ✓ Most users are not looking for specific information or not really interested on health care issues

MOBILITY AND HEALTH	
	✓ Users use different media like magazines, TV, internet. One user directly asks his doctor, if he is interested on health care topics

Table 30. Mobility and health in "active elderly"

MOBILITY AND HEALTH	
NORMAL elderly	**Objective health condition (diseases, medication …)** ✓ Most users take medication and have age-related symptoms ✓ Users try to practice physical exercises, but some of them gave up because of the pain **Physical activity** ✓ All of the users go for a walk regularly ✓ Most of them given up with any physical activity because of the pain. They just do the household and try several gyms **Subjective health condition (health perception)** ✓ Users have good health conditions with some restrictions ✓ Some of them are afraid that their condition is ebbing with the age **Sources of information on health care** ✓ Most of them use TV, magazines to get for health care informations

Table 31. Mobility and health in "normal elderly"

MOBILITY AND HEALTH	
FRAIL elderly	**Objective health condition (diseases, medication …)** ✓ All of them take medication ✓ Most user had a surgery **Physical activity** ✓ Users are not active like before. Except of one user none of the users practice any physical activity ✓ Some of them use a walking stick for a walk, but all of them go for a walk regularly and try to keep active **Subjective health condition (health perception)** ✓ No similarities in subject health condition. Some of them feel in a good health condition, some of them feel unsteady and old. **Sources of information on health care** ✓ Use magazines, TV, talking to peers and doctor

Table 32. Mobility and health in "frail elderly"

ASPECTS RELATED TO FALLS (all participants, N=22)

FALLS
ACTIVE elderly	**Falls** ✓ Except of one none of the users has ever suffered any fall in their adulthood **Risk factors** ✓ Except of one none of them have no fear of falling **Interest in receiving information on falls prevention** ✓ Users are interested in receiving information on falls prevention

Table 33. Falls in "active elderly"

FALLS
NORMAL elderly	**Falls** ✓ Except of one none of the users has ever suffered any fall in their adulthood, but some of them say, that the risk to fall rises with the higher status of age **Risk factors** ✓ No similarities **Interest in receiving information on falls prevention** ✓ Users are interested in receiving information on falls prevention

Table 34. Falls in "normal elderly"

FALLS
FRAIL elderly	**Falls** ✓ 3 users have fall experiences in their higher age. Other users have never fallen down in their elderly time **Risk factors** ✓ Some users are afraid of falling, but 2 users are not afraid to fall ✓ Some of the users have emergency button or bracelet to make them feel safer ✓ Some of them use walking stick for a walk and walk safely **Interest in receiving information on falls prevention** ✓ Users are interested in receiving information on falls prevention

Table 35. Falls in "frail elderly"

ASPECTS TO THE USE OF MEDIA (all participants, N=22)

USE OF MEDIA	
ACTIVE elderly	**Frequency and use of media** ✓ Users watch TV, read books and magazines and listen to the radio ✓ Most users can use a computer and surf the internet **Problems with the use of media** ✓ None of the users has any problems using the media **Circumstances that would facilitate the use of media** ✓ Simple introductions, straight language and clearer systems

Table 36. Use of media by "active elderly"

USE OF MEDIA	
NORMAL elderly	**Frequency and use of media** ✓ Users watch TV, read books and magazines and listen to the radio ✓ Most users have mobile phone and use a computer **Problems with the use of media** ✓ Some users have problems using computer and mobile phone due to the lack of experiences. They are not interested in learning to use it because they think they do not need it. Other users have no problems **Circumstances that would facilitate the use of media** ✓ Some users note that there are problems with usability, small letters and too much redundant info. Other users do not know how they would use it easier

Table 37. Use of media by "normal elderly"

USE OF MEDIA	
FRAIL elderly	**Frequency and use of media** ✓ Users watch TV, read books and magazines and listen to the radio **Problems with the use of media** ✓ Most of them do not like to use modern technology because they do not like them or do not feel any joy in its use **Circumstances that would facilitate the use of media** ✓ Different suggestions for improvement like easier technical terms, good introduction, simplified language

Table 38. Use of media by "frail elderly"

ASSESMENT OF THE GAMES AND THE MOBILITY MONITOR (all participants, N=22)

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR	
ACTIVE elderly	**Previous knowledge** ✓ Most users have no knowledge on the field, but some users know Nintendo DS, Wii or Xbox through their grandchildren **Use of video games** ✓ Have no experiences on the field or they think it is more suitable for children **Suggestions** ✓ Different suggestions for improvement like a combination of physical and memory training, should be adapted to adults and have an objective **Context of use** ✓ Most users would like to play the game in team with the family or other people **Assessment of the SMM** ✓ No similarities

Table 39. Assessment of the mobility monitor in "active elderly"

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR	
NORMAL elderly	**Previous knowledge** ✓ Users know about these field but have no experiences in playing them **Use of video games** ✓ Some of them played games such as brain or balance training **Suggestions** ✓ Video games should be adapted to elderly people and easier to use **Context of use** ✓ Except of two users they would like to play alone ✓ All of them would like to play at home in the living room **Assessment of the SMM** ✓ Users think that might be interesting for older people

Table 40. Assessment of the mobility monitor in "normal elderly"

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR	
FRAIL elderly	**Previous knowledge** ✓ Users have no experiences on this field **Use of video games** ✓ Most users have never played video games

ASSESSMENT OF THE GAMES AND THE MOBILITY MONITOR
Suggestions ✓ different suggestions for improvement like gymnastic games, virtual walks in different cities, more user-friendly to use, music would engage people **Context of use** ✓ no similarities **Assessment of the SMM** ✓ Users find it very interesting

Table 41. Assessment of the mobility monitor in "frail elderly"

ASPECTS RELATED TO PRIVICY AND DATA SECURITY (all participants, N=22)

PRIVACY AND DATA SECURITY	
ACTIVE elderly **NORMAL elderly** **FRAIL elderly**	✓ None of the users refuses to provide information about their health condition for the computer system ✓ They do not see any problem if the information given is used for medical purposes ✓ All users would accept that their movements were continuously monitored and would not mind carrying the necklace at home ✓ They like the idea of customizing their activities and movements ✓ They would like to share this information with family and health professionals

Table 42. Privacy and data security (all participants)

OTHER ASPECTS (all participants, N=22)

OTHER ASPECTS	
ACTIVE elderly **NORMAL elderly** **FRAIL elderly**	✓ All the users interviewed would be willing to use the system and most of them prefer to use it alone with the possibility to be accompanied ✓ All of the interviewees except two have access to the Internet and the medial properties ✓ All users have a flat screen TV in their living room ✓ All users think that the system is very useful and that it can improve the quality of life of elderly people as well as prevent falls in the future

Table 43. Other aspects (all participants)