Updated guidelines for design and implementation of technologies March 2015

SEVENTH FRAMEWORK PROGRAMME

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Document History

Version	Date	Comments	Author
V0.1	13/02/2015	First working draft circulated to partners	UMAN
V1.0	27/02/2015	Final version	UMAN, UNIBO, NTNU, DSHS

1. Executive Summary

This document presents the results of deliverable D2.5: 'Final guidelines for the design and implementation of technologies' for work package two (WP2) of the FARSEEING project. WP2 aims to identify users' perceptions about technologies aimed both to monitor and reduce risk of falls and to promote independent living.

These guidelines are drawn from the FARSEEING systematic review of older adults' perceptions of technologies aimed at falls prevention, detection or monitoring; the outcomes of stakeholder consultations; the usability testing in work package five (WP5) of three off-the-shelf exergames; the usability testing of the smart home and smart home technologies being developed as part of work package seven (WP7); and the focus groups held with older adults and professionals in relation to the falls alarm trial in work package five (WP5). As such, the recommendations presented here are developed from best evidence reviews to create guidance on designing and implementing ICT technologies in the area of fall prevention and promotion of independent living amongst older people.

These guidelines present easily accessible (non-technical) recommendations, aimed at scientists, clinicians, technologists, manufacturers etc., which outline the principles for making ICT technologies acceptable to older adults. These recommendations will be widely disseminated by print media and internet as appropriated. The guidelines and reports will make these principles accessible to stakeholders.

This update to the previously published preliminary guidance includes additional feedback from older adults and from further consultation with stakeholders across Europe.

The recommendations are presented in section five. The general principles underlying the recommendations are that technologies must be easy to use and person- or user-centred, enabling users to maintain the highest possible quality of life. They fall under three overarching headings: usability and design issues; personal motivations; and promoting new interventions to populations and stakeholders. Under each heading, there are a number of recommendations for action. For each recommendation, evidence from one or more of the five FARSEEING studies is provided.

2. Purpose and scope

Best practice guidelines are statements which have been systematically developed in order to assist with decisions about appropriate action (Field & Lohr, 1990).

These guidelines have been developed with the following purpose and scope:

- To increase knowledge, skills, abilities and confidence in developing, implementing and encouraging the uptake of ICT interventions in the area of fall prevention and promotion of independence, including novel self-adaptive environments.
- To include ICT interventions that focus on detecting and / or preventing falls and promoting independent living. Does not include ICT interventions that have no relation to falls prevention (e.g. electronic care records).
- To be relevant for clinical practice; primary health care; ambulatory health care; long term care; community based care; independent community dwelling older adults and their carers.

These guidelines will assist in the identification of ICT interventions which have been accepted by older adults. They will help clinicians, practitioners, policy makers, older adults and their carers to understand why some ICT interventions can be unpopular and to consider approaches which may encourage older adults to accept interventions that can promote independence and reduce the incidence of falls.

3. Development of the guidelines

Best practice guidelines are developed from the best available research findings. Prior to the work of the FARSEEING project, evidence regarding older adults' acceptance of ICT interventions to detect and prevent falls and to promote independent living was limited. These guidelines have been developed from the following five sources:

- The systematic review undertaken as part of work package two (WP2) of the FARSEEING project.
- The stakeholder consultation carried out as part of work package two (WP2) of the FARSEEING project, including the extension to include input from stakeholders in their native languages carried out in November and December 2014.
- The usability testing of three 'off-the-shelf' exergames undertaken as part of work package five (WP5) of the FARSEEING project.
- The usability testing of the touchscreen interface undertaken as part of work package seven (WP7) of the FARSEEING project.
- The focus groups held with older adults and with professionals as part of the falls alarm trial (WP5).

Systematic Review

A systematic review presents all of the evidence on a clearly defined issue, in order to answer a specific research question. Explicit, reproducible methods are used in order to minimise bias and generate findings

which can be regarded as more reliable. Evidence from different studies is sythesised in order to assist in the development of conclusions and subsequent decisions (Green et al., 2008).

The FARSEEING systematic review, 'Users' perceptions of technologies aimed at falls prevention, detection or monitoring', included all types of study designs, where studies included older adults aged 50 years and over. The included studies were concerned with technologies related to falls prevention, detection and monitoring and used directly by older adults. Evidence from these studies was related to older adults' attitudes, experiences and feedback on the technologies and interventions.

Systematic searches were undertaken of MEDLINE, EMBASE, CINAHL and PsychINFO, the engineering database COMPENDEX and the Cochrane database. No date restrictions were placed on the search and all relevant evidence was included if in the English language. Key search terms included 'older adults', 'seniors', 'preference', 'attitudes' and a wide range of technologies. They also included the key word 'fall*'. The electronic searches are up to date at 01 April 2013. Inclusion and methodological quality was discussed against agreed criteria by three reviewers. Some 76 potentially relevant papers were identified through the searches with 23 being included in the final review.

Full details of the FARSEEING review can be seen in the published paper in the International Journal of Medical Informatics (Hawley-Hague et al., 2014). The findings from this review form part of the recommendations presented in section five of this document.

Stakeholder consultation

Following on from the FARSEEING systematic review, the stakeholder consultation also sought to focus on how to encourage older adults to accept and adopt ICT interventions that would promote independence and reduce the risk and incidence of falls. 'Stakeholders' are defined as individuals who have a vested interest in particular issues and decisions, who can influence actions and decisions (Baker et al., 1999). In the case of this consultation, the stakeholders contributed their working knowledge of promoting the use of ICT interventions to older adults and provided suggestions for how the FARSEEING technologies might be successfully promoted. Some 30 stakeholders (participants) were recruited through all 10 partners in the FARSEEING project and were recruited from services and organisations in Germany, Italy, Norway, Switzerland and the UK. The country of origin and gender of the stakeholders in reported below:

Country of origin	Female	Male
Germany	2	2
Italy	2	5
Norway	5	0
Switzerland	4	3
UK	3	4
Total	**16**	**14**

For the first iteration of the best practice guidance, the stakeholders engaged in virtual discussions on an online forum and 24 completed an online questionnaire. All responses were provided in English. The questions asked on the online questionnaire are included in Appendix 1. For this update of the guidelines, further questionnaires were developed in native languages in order to expand the reach of the consultation and 6 additional questionnaires were completed. The English language questionnaires were translated into German and Norwegian, by researchers in work packages five and nine, and were subsequently made available online. Anonymised versions of the questionnaire responses were returned to the researchers, for translation back into English, before the data were analysed.

Usability testing

The usability testing undertaken by FARSEEING researchers at the Norwegian University of Technology and Science (NTNU) has also contributed to the development of these guidelines and recommendations. Iterative processes of testing and development lead to successful implementation, with laboratory testing contributing to these processes. Within work package five (WP5) of the FARSEEING project is the task of assessing end user acceptability through examining usefulness and usability of the smartphone and smart home technologies. User-centred design processes have been used to evaluate the technologies to be included in the project (Haklay & Nivala, 2010).

Two different usability studies are included: the testing of exergames and the testing of the prototype FARSEEING touchscreen interface. Three ‘off-the-shelf’ exergames were tested by 14 older adults aged 65 years and older: ‘The Mole’ by SilverFit; ‘Light Race’ for the XBox 360 and a modified version of ‘Dance Dance Revolution’. All three games were evaluated as different types of step-based balance training exercises. The older adults evaluated the games according to their preferences, describing the elements of the games that motivated them or dissuaded them from taking part. The FARSEEING touchscreen interface was tested by 5 older adults aged 65 years and older. Participants were asked to comment on ease of use, possible improvements and their motivation to and likelihood of using the FARSEEING system in their homes.

Full details of the usability testing undertaken can be found in the usability study ‘Step-based Exergames Used in Balance Training for Seniors’ (Ystmark, 2013), in papers published as part of the FARSEEING project (Nawaz et al., 2014a; 2014b; 2014c; Skjæret, 2015) and in previous deliverables (‘Deliverable D5.2 Validation strategy of the user interfaces, the fall risk assessment service & the exercise guidance service’; and ‘Deliverable D7.3 Design of self-adaptive intervention’).

Focus groups

The falls alarm trial was conducted in two Norwegian public care centres, in Trondheim, where care was provided to people with a range of care needs. The majority of people living in the care centres were over 65 years old; some received full nursing care and others lived more independently, receiving home care support. The trial was designed to investigate users’ perceptions on a prototype personal emergency alarm system, using a belt with an inbuilt motion sensor (an Android application running on a Samsung Galaxy S III mobile phone). The sensors embedded in the smartphone, (tri-axial accelerometer, gyroscope and magnetometer) allowed the app to continuously monitor motions that could indicate a fall. Six male and 14

female participants took part in the trial, keeping a log book which included their views on the system; meeting with care givers on a weekly basis and participating in focus groups at the end of the trial. The user perceptions included in these guidelines come from the four post-trial focus groups held with eight care receivers and four care providers, following formal qualitative data analysis.

Two further focus groups were held, in Trondheim, with older adults and professionals who were not directly involved in the trial to explore their views regarding the prototype system and a falls risk assessment model. The questions and themes for these focus groups can be found in Appendix 4. Full details of the trial and of the focus groups can be found in the work package five (WP5) 'Deliverable D5.4: Implementation and evaluation of telemedical services and models.'

4. Background and context

Falls are an important public health issue. Each year, 35% of over-65s experience one or more falls. About 45% of people aged over 80 who live in the community fall each year. Between 10 and 25% of such fallers will sustain a serious injury (Department of Health, 2009). This has implications in terms of independence, quality of life and also cost to the health service (DH, 2009). Hip fracture is the most common serious injury related to falls in older people and death rates are continuing to rise (Centers for Disease Control and Prevention, 2013). Each year approximately 10% of the elderly population (65+) will be treated by a doctor for an injury and approximately 100,000 older people in the EU27 and EEA countries will die from injury from a fall (Eurosafe, 2013).

Over recent years a number of Information and Communication Technologies (ICTs) have emerged aimed at falls prevention, falls detection and alarms for use in case of fall. There are a range of ICT interventions that have been adopted to monitor falls and alert professionals or carers if a fall occurs (Brownsell & Hawley, 2004), these can also include home automation systems. To date these technologies tend to be re-active, which help to reduce a long lie and allow help to be brought quickly to the person who has fallen. There are also a range of ICT interventions which have been created or adapted to be pro-active in preventing falls, such as those which provide strength and balance training to older adults in the prevention of falls e.g. exergames, Wii-fit, Kinect (Miller et al, 2012; Williams et al, 2010). There is increasing evidence that exercise programmes that include specific strength and balance exercises can significantly reduce the risk and rate of falls (Sherrington et al, 2011 & 2008; Gillespie et al, 2009; Skelton et al, 2005; Robertson et al, 2001) and therefore ICT innovations which can deliver these in the home have the potential to reduce cost and increase adherence.

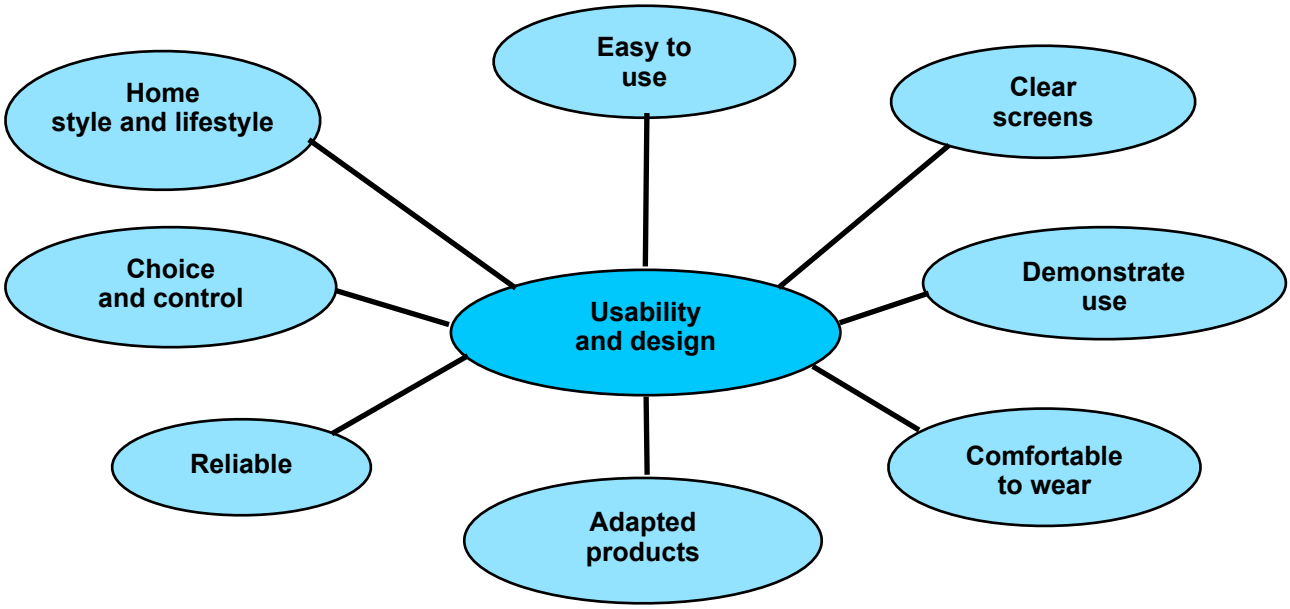
FARSEEING is a collaborative European Commission funded research project with 10 partners distributed in 5 EU countries. It aims to provide a thematic network focusing on the issue of promoting healthy, independent living for older adults. FARSEEING aims to promote better prediction, identification and prevention of falls with a focus on ICT devices and the unique proactive opportunities they can provide to older adults to support them in their own environment. FARSEEING technologies include the use of a smartphone, smarthome and also an exergame and virtual reality. One of the main issues with use of ICT devices in the home, is related to usability of the systems. We know very little about older adults' attitudes towards falls interventions that use technologies. There is some general evidence around a range of intrinsic

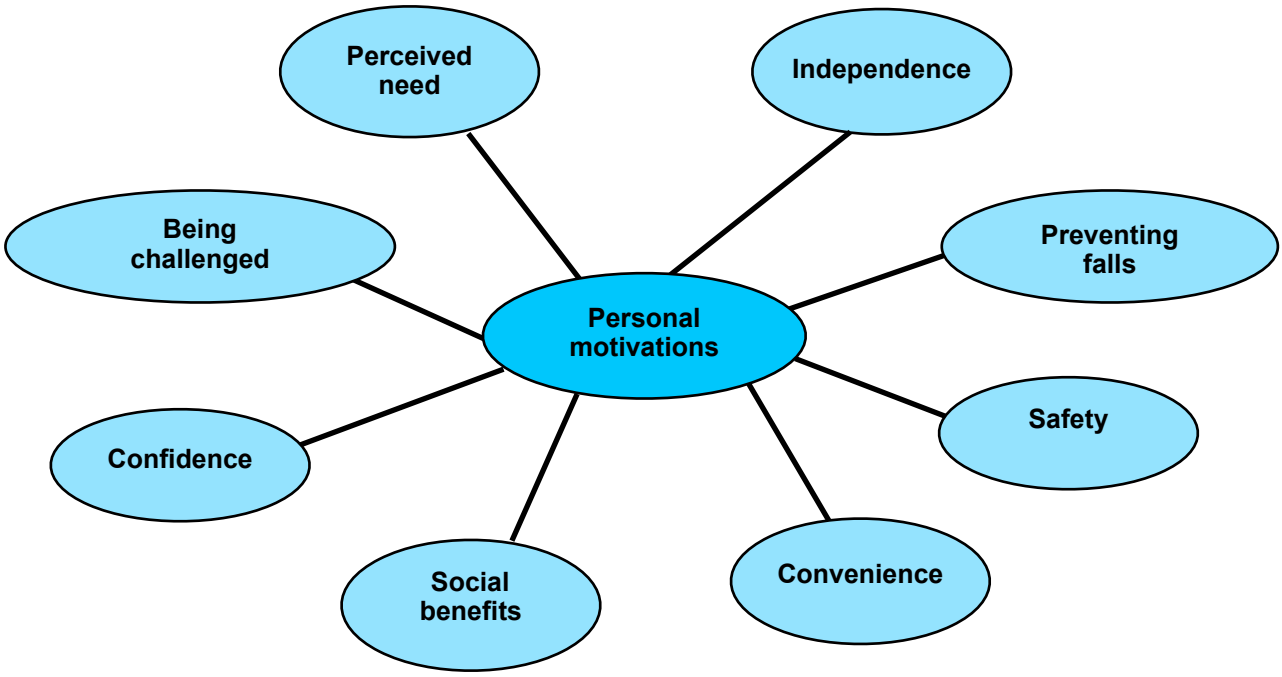
factors which motivate older adults to take up the use of ICT devices. Independence has been previously cited as a key reason why people engage in falls prevention activities and also home exercise (Hawley, 2009; Yardley et al, 2006; 2006a, 2007). It has also been found to be a key factor in promoting older adults to take-up ICT devices in their homes, often because they do not want to be a burden, have a fear of being put in long term care, or because they feel it will promote their social life (Finkelstein, 2011; Steele et al, 2009; Zwijsen et al, 2011). Extrinsic factors which may motivate older adults to take up ICT devices include pacifying family members and cost reduction especially in countries with private/self- funded health care (Demeris et al, 2000). There is also a range of barriers that prevent older adults from taking up ICT devices and also their long-term use. These include fear over the effect on the quality of care they receive and access to care (Demeris et al, 2000), particularly the reduction of face to face contact, which could lead to isolation and loneliness; concerns around patients being able to explain their needs adequately through a device (Demeris et al, 2000); concerns about the practical use of devices, such as self- efficacy issues; fear of the equipment and false alarms. Such devices can 'medicalise' their home and make it no longer feel like a home. Such equipment may stigmatise the user, identifying them as 'old and frail' (Demiris & Hensel, 2008; Zwijsen et al, 2011, particularly if aesthetics have not been considered and it is noticeable or identifiable (Velez, 2011). There are also ethical issues that arise in relation to the use of ICT devices, such as confidentiality, privacy and the fact that older adults may be particularly resistant to being filmed or photographed (Van Hoof et al, 2011; Zwijsen et al, 2011).

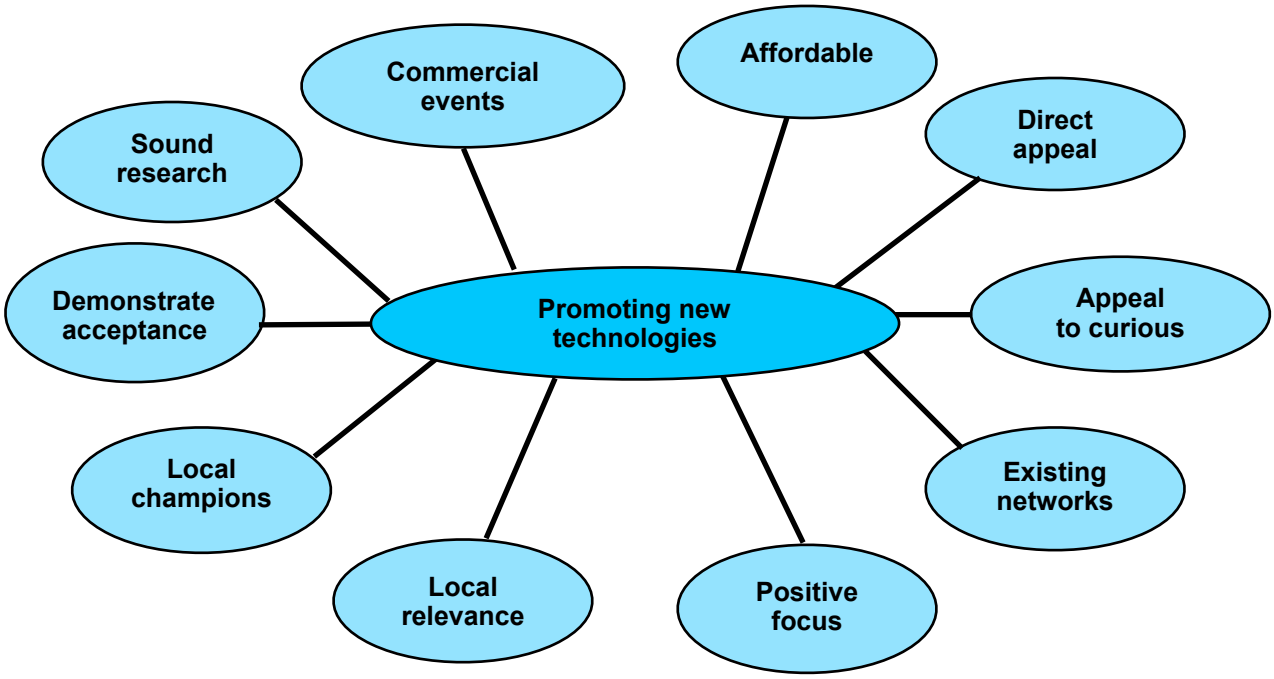
The limited evidence available suggests that older adults do not always have a clear conception of what the benefits are to them of taking up the technology and that this is something that needs to be considered. The take-up of ICT devices seems to mainly revolve around prevention of negative consequences. The positive outcomes that they can achieve need to be clearly outlined as well, if we wish to motivate older adults to participate. Although, the general literature around ICT interventions is useful to the development of interventions in FARSEEING, the FARSEEING systematic review provides specific evidence based guidance related to the attractiveness of specific ICT interventions and monitoring equipment, directly related to falls prevention and detection, proposed within the FARSEEING project. Previous reviews of ICT by Cochrane Group (Martin et al., 2008) have found that there is a lack of eligible randomised controlled trials (RCTs) in this area. The FARSEEING review draws together the literature that does exist (RCT, case studies, cohort studies, quasi experiments, qualitative and other methods) to provide a summary of existing knowledge and identify gaps which can be filled by older adult and stakeholder consultation.

5. Practice Recommendations

The recommendations in this section are organised under three main headings: usability and design issues; personal motivations; and promoting new interventions to populations and stakeholders. Under each heading, there are a number of recommendations for action. For each recommendation, evidence from one or more of the four FARSEEING studies is provided. The recommendations are summarised as follows:







5.1 Usability and design issues

During the stakeholder consultation, it was reported that many older adults regarded themselves as too old to learn how to use technology; that equipment and systems were too complex; that their fluctuating or declining physical and mental health adversely affected their ability to learn how to use something new. The importance of simple, reliable technologies was also found in the systematic review and in the usability testing studies. Ensuring that ICT interventions are designed to be as easy as possible to use should be given a high priority by developers. The importance of usability has already been addressed in the development of the FARSEEING technologies and the feedback from older participants in the InCHIANTI study group has indicated high acceptance with regard to comfort and ease of use (Deliverable D4.4 'Preliminary report on the information collected with the Smartphone technology'.) In this section, there are eight recommendations regarding usability and design.

5.1.1 Technologies should be easy for the older adult to use

Technologies should be easy to set up, requiring little or no active intervention from the user. Technologies should be easy to operate.

Ease of use was identified in all five sources of evidence used to develop these guidelines. Studies regarding use of iPad applications to promote physical activity and using virtual T'ai Chi classes via teleconferencing found high levels of satisfaction with the interventions. They reported that little help was needed with operating and interacting with the technologies beyond the initial training period (Silveira et al.,

2013; Wu et al., 2006). In the usability testing of the exergames, participants reported that they would find it difficult to set up the games consoles at home and that this would prevent them from using the games on their own. They would need someone to come and set it up for them (Nawaz et al., 2014a; Ystmark, 2013). Participants in the usability testing of the FARSEEING touchscreen interface reported that they would be able to use the system on their own, that it was simple to use and that they were likely to adopt it in their own homes (Nawaz et al., 2014b). From the stakeholder consultation, participants reported that technologies had been successfully used when there was little or no active intervention needed on the part of the user. Success had also been achieved through 'starting small', with simple pieces of equipment and technology that older adults found easy to use. There was a feeling that if a mastery of computers or technologies were required, this would be off putting to many older adults, who had a poor view of their own ability to learn a new skill. Fear of making mistakes and breaking equipment was also reported by some stakeholders. In addition, the issue of smartphone battery life was raised in both the extended stakeholder consultation and the falls alarm focus groups. It was felt that having to charge a phone too often would discourage use; it would be inconvenient, with too much input required from the older adult. Older adults involved in the falls alarm trial stated how important it was to them to be able to manage the personal alarm system for themselves. Some of the participants found it difficult to manage the belt buckle, due to limitations in manual dexterity and strength. Others struggled with connecting the charging pin to the smartphone. Attention should be given, not just to the design of the technology, but also to the way in which it is worn or used.

5.1.2 Display screens should be clear and easy to read

Technologies including screens should have large, clear fonts and clear routes of navigation between screens.

During the usability testing of the FARSEEING smart home touchscreen interface, participants reported difficulties in reading the text on the screen. The screen had been designed using evidence regarding display screens for people with visual impairments, yet the font was still found to be too small (Nawaz et al., 2014b). This issue was also found in the stakeholder consultation with one participant reporting that even very big characters were considered too small. One study in the systematic review reported that grey text on a grey screen was too difficult to read on a wrist device, so the device had not been used. Difficulties using touchscreens were reported by several participants in the stakeholder consultation and by the participants in the FARSEEING usability testing. Touchscreens are very sensitive and require precision in movement, which some older adults are not capable of, particularly in the case of Parkinson's Disease. Some confusion arose in the usability testing of the FARSEEING interface, as there was a mixture of two different operating systems (the FARSEEING screens sat within an overarching system). It was not clear how to navigate between and within the two sets of screens. In addition, it was found that the screen turning black after only 45 seconds of inactivity was too short a time period, without showing a warning or a message for changing the status of the screen into inactive mode. The importance of good design with regard to clear display screens was reiterated in the extended stakeholder consultation, with ease of operation being linked to thoughtful design.

5.1.3 Older adults should be given demonstrations on how to use technologies

Technologies should be clearly explained and demonstrated to older adults, both how to operate them and the benefits that they can bring.

Two studies in the systematic review reported that participants had been able to use the technologies without difficulty, following demonstration by the researchers (Silveira et al., 2013; Wu et al., 2006). In the usability studies, participants were able to operate the touchscreen interface and the exergames following demonstrations and under the guidance of the researchers. In the case of the FARSEEING touchscreen interface, participants reported that an animated demonstration of how to perform the exercises suggested would be desirable (Nawaz et al., 2014b). In the stakeholder consultation, many participants emphasised the importance of patient, careful explanation and demonstration of how to use technologies. In addition, several stakeholders reported that explaining the potential benefits of using technologies, showing older adults examples of success, had encouraged those older adults to adopt and engage with the technologies themselves. Showing older adults how to use the technologies helped to overcome the fear of getting it wrong, or the fear of the unknown. Face-to-face demonstrations and explanations can be supported by videos and illustrations of how to operate technologies. Demonstrating how to use technologies and explaining their potential also had a role to play in facilitating informed decision making about uptake. In the extended stakeholder consultation and in the focus groups held as part of the falls alarm trial, the benefit of learning by using the technologies was highlighted. Opportunities to try using technologies should be provided.

5.1.4 Body worn or body fixed technologies should be comfortable to wear

Developers should ensure that methods of attaching sensors, or carrying smartphones are as comfortable and unobtrusive as possible.

Two studies in the systematic review reported on the importance of body worn or body fixed technologies being comfortable to wear (Brownsell & Hawley, 2011; Heinbuchner et al., 2010). Wrist worn devices were preferred to other devices, as these were more comfortable. This was echoed in the stakeholder consultation by one participant who reported experience of waist bands being unpopular, with older adults preferring wrist worn, or necklace type devices. In the focus group held with professionals, for the falls alarm trial, participants stated that they thought the smartphone in the waist belt would be too large and uncomfortable for long-term use; that a smaller device and alternative wearing location would be needed. This was indeed reported by some of the older adults involved in the trial, who spent large amounts of time sitting in wheelchairs. The bulky nature of the belt-worn smartphone caused discomfort. However, some participants were able to mitigate this by moving the smartphone around to their side, above the hip, where there was more room in the wheelchair. Usability testing within work package four of the FARSEEING project demonstrated high acceptance of a waist worn smartphone (see Deliverable D4.4 ‘Preliminary report on the information collected with the Smartphone technology’). However, it is important to note that usability testing in a laboratory takes place over relatively short periods of time. Assessing to what extent different locations of wearing body sensors are comfortable requires users to wear the sensors over longer periods of time. Therefore, it is not possible to definitively recommend one method of wearing body worn technologies over another. However, the common factor in all of these cases is that of the need for comfort. Participants in the

stakeholder consultation reported that technologies had been rejected when they were regarded as difficult to wear, too cumbersome and uncomfortable.

5.1.5 Consider adapting 'off-the-shelf' technologies for use by older adults

Where technologies have been shown to be effective but are difficult to operate, they should be adapted for use to simplify their operation.

The usability testing of the exergames included a modified version of *Dance Dance Revolution*, designed for the senior user group (Shoene et al., 2013); *The Mole* from SilverFit virtual reality rehabilitation system (Rademaker et al., 2009), designed specifically for older adults' rehabilitation needs; and *Your Shape: Fitness Evolved Light Race* game for PC, which was not modified for use by older adults. The games that were modified, or designed specifically for older adults, demonstrated the best usability, with SilverFit's *The Mole* being the most popular (Nawaz et al., 2014a; Nawaz et al., 2014c; Skjæret et al., 2015; Ystmark, 2013). Findings from both iterations of the stakeholder consultation echoed these findings, with reports that using games consoles could be successful with older adults, if the operation of games could be adapted to suit older adults. Games should be challenging for older adults, without being so complex that mastery of a particular game or level is beyond reach. Games should have an entertaining concept with progress through levels that produces sufficient challenge and achievement. Some stakeholders reported that older adults had experienced difficulty hearing audio messages, instructions and alerts. Technologies with audible components should incorporate the option for very high sound levels. The importance of feedback on performance, as motivation to continue with activity or exergame use, was reported both in the extended stakeholder consultation and in the falls alarm trial focus groups. The older adult focus group members were clear that they would not want this feedback too often, as they said they would most likely find this irritating, although they accepted that some feedback would act as a motivator for them. As such, the type and amount of feedback should be tailored to individual needs and preferences. Adapting technologies so that they would be suitable for use with those experiencing cognitive decline was reported as a challenge in the extended stakeholder consultation. Professionals in the falls alarm trial focus group also described difficulties in using technologies with those experiencing dementia, as wearing compliance was reported as poor. Some older adults with cognitive impairments would forgot to wear their devices, or would put them down somewhere and forget where they had left them. This does present challenges for design and implementation.

5.1.6 Technologies must be reliable

Technologies should perform as expected in order to optimise uptake and adherence by older adults.

Evidence from the systematic review and the stakeholder consultation demonstrates that older adults had rejected technologies when they were not regarded as reliable. This was particularly the case with regard to falls alarm systems. False alarms were an irritation and inconvenience to older adults themselves, their families and neighbours (Holzinger et al, 2010; Horton 2008; Hsin-Kai et al, 2012; Londei et al, 2009; Van Hoof et al, 2011). Several participants in the stakeholder consultation reported that false alarms created a problem with older adults' acceptance of technologies. The alarms either reacted too often, as the

parameters had been set too low by risk-averse health professionals, or they did not react at all. Older adults involved in the falls alarm trial agreed that it was vital to be able to trust the technologies to work and not to give off false alarms and to accurately identify a fall when one has occurred. Linked to this trust was the knowledge that the system was working. The older adults wanted a system status notification to reassure them that it was switched on. Stakeholders involved in the first phase of the consultation reported that whilst motivation to use technologies was high when older adults found them useful, this motivation quickly disappeared when the technologies failed or were too difficult to use. Other reasons for rejecting or giving up on technologies were difficulties in connecting devices to systems, such as falls detectors to alarm systems; and insensitivity of technologies. The lack of a common platform for different technologies further complicates connecting devices to existing systems. Accuracy of feedback was also an issue in the usability testing of the exergames. Participants received feedback when they had not hit a target, but did not understand whether they had missed it through failure in direction, target hitting or timing, or inaccuracy of the monitoring system. The mirrored game *Light Race* was particularly difficult to play, as it required stepping forwards when the target seemed to appear behind the image on the screen (Nawaz et al., 2014a; Nawaz et al., 2014c; Ystmark, 2013). Technologies must perform as expected and accurate feedback should be provided in order to encourage older adults to continue to use them.

5.1.7 Older adults must be able to control the use of technologies

Older adults must be able to choose when technologies are used; be able to deactivate false alarms and feel in control of the use of technologies in their homes.

The importance of older adult users having control over technologies, with particular regard to false alarms and privacy, was an important finding of the systematic review with nearly all studies making reference to this factor. Not having the facility to deactivate a false alarm was given as a reason for rejecting technologies. Older adults wanted to be able to control the situation themselves. Cameras were often rejected as an invasion of privacy, except for when the trade off between independence and privacy was deemed acceptable (van Hoof et al., 2011). Where cameras were accepted, a blurred or outline image was preferred and clear images were only accepted in areas of the home such as the kitchen or living room (Londei et al., 2009; Milhailidis et al., 2010). The feeling of being in control was also reported as a motivational factor in using technologies in the stakeholder consultation, along with the dissatisfaction of not being able to override false alarms. Invasion of privacy was cited by some stakeholders as a reason for rejecting technologies. Some older adults did not want to feel supervised; they disliked the invasive nature of the technologies monitoring their activities. This was echoed by the older adult focus group members from work package five (WP5), who liked the idea of receiving feedback about their health status and activity levels, but were not happy about being ‘under surveillance’. They wanted to be in control over what information was shared and with whom. If data about their activity levels was picked up by their usual doctor and was used to improve care and advice, then this was thought to be acceptable. The older adults who had taken part in the falls alarm trial liked the idea of being able to cancel an alarm, although this caused concern to the care providers involved in the trial. It was thought that care receivers might cancel an alert by mistake, or cancel an alert out of fear of creating a burden to staff members, when they really needed help.

5.1.8 Technologies must fit in with home style and lifestyle

Designers should consider aesthetics in addition to usability issues. Style and substance are both important.

Studies in the systematic review reported the importance of technologies fitting in with older adults' existing strategies and spaces. Devices should be unobtrusive and available in different colours. Systems and technologies in the home should not make their home look like a hospital (Blythe et al., 2005). Stakeholders confirmed this view, stating that where devices had been conspicuous, unattractive and intrusive, they had been rejected by users. One particular example from the extended stakeholder consultation was the rejection of devices with flashing lights, which the older adult had found irritating and unacceptable. Aesthetics are important and designers should consider style as well as usability. Several of the participants in the usability testing of the exergames reported that they would not have sufficient space to play the games in their own homes; that they would have to move furniture out of the way and this made it unlikely that they would make the effort to play (Nawaz et al., 2014a; Ystmark, 2013). Finding ways to make technologies fit in with existing living arrangements is therefore important.

5.2 Importance of personal motivations

Evidence from the FARSEEING studies shows that there is great diversity in the acceptance of, and willingness to use, different technologies. Some older adults are very confident using various technologies such as personal computers, smartphones and games consoles. Others describe being afraid of using devices and systems. They are afraid of something going wrong; that they might break the equipment; that the technology will fail; or that their privacy is being compromised. Whilst some stakeholders involved in the consultation stated that younger older people seemed more likely to accept ICT devices and systems, other evidence suggests that acceptance is not always related to age. Instead, our research indicated that it is more important to find out what motivates individuals to use technologies. It was reported that the key factor in overcoming the 'entry barrier' to adopting technologies is finding a motivation.

Eight different personal motivations are presented in this section. Underpinning them all is the importance of seeing the need for any ICT intervention and understanding the outcomes that can be achieved through using the technologies. Benefits to health and quality of life are important, as are having goals and targets that are achievable. In terms of encouraging older adults to use technology, one size will not fit all. Rather, technologies should be personalised according to the users' preferences.

5.2.1 Focus on the possibility of regaining or maintaining independence

Technologies can enable older adults to continue to live in their own homes and can help maintain autonomy.

Five studies in the systematic review reported on the importance of maintaining independence with regard to the acceptance of technologies (Blythe et al., 2005; Brownsell & Hawley, 2004; Heinbuchner et al., 2010; Londei et al., 2009; van Hoof, 2011). This was supported by the findings in both iterations of the stakeholder consultation where maintaining independent physical function was cited by many participants as a primary

reason for older adults accepting technologies in their homes. Being able to live in their own homes, by themselves, for as long as possible and thus avoiding a change in their lifestyle habits was a strong motivation for acceptance. Autonomy was cited often. In addition, the means of overcoming a specific problem was also cited as motivation to accept technologies. Regaining the ability to read independently through using an application on a tablet motivated one older adult to accept technologies and was a route to accepting further technologies to support her independence.

5.2.2 Falls prevention as motivation to use technologies

Technologies can help to prevent falls and ensure a rapid response in the event of a fall.

A specific factor in relation to the maintenance of independence is that of preventing falls. Whilst preventing falls was not given as a primary reason for accepting technologies, one study in the systematic review found that the existence of falls alarms or systems enabled the older adults to take more risks (Horton, 2008). Preventing falls was cited more often as a reason for accepting technologies in the stakeholder consultation. This was also described in terms of the technologies having the possibility to prevent 'bad events' and to alleviate difficulties in daily life. Some stakeholders reported that this was a major motivation in older adults' acceptance of technologies in their homes and is linked to the following issue of feeling safe and secure. Due to the nature of the trial, there was much discussion of the importance of falls prevention in the falls alarm trial focus groups. In discussing the potential of the smartphone app, a reduced fear of falling was reported along with increased confidence in taking risks.

5.2.3 The importance of reassurance and feeling safe

Increased feelings of safety and security can be a strong motivation to accept technologies within the home.

Six studies in the systematic review reported on improved safety as a reason for older adults accepting technologies (Brownsell & Hawley, 2004; Heinbuchner et al, 2010; Londei et al, 2009; Hsin-Kai et al, 2012; Horton, 2008, van Hoof, 2011). This was particularly the case for technologies that were connected to response systems and provided real-time monitoring. One study in the systematic review found that the benefit of improved safety, and security and the independence that this brought, was sufficient for participants to accept the perceived invasion of privacy by the technologies in the home (van Hoof et al., 2011). In the stakeholder consultation, the most commonly cited reason for older adults accepting technology within their homes was that of feeling safe and secure. In some cases, this related to the constant monitoring provided by sensors and older adults reported that they felt secure knowing that they were being 'watched over' or 'followed'. In other cases, it was the possibility of being able to speak to someone at the touch of a button that brought about their feelings of safety and security. Family members were also reassured by the technology being in the older adult's home. It was reported by stakeholders that family members were confident that measures had been put in place to ensure that the older adult was as safe as possible at home; they did not need to consider residential care for their relative. Providing this reassurance to family members was given by one stakeholder as an example of the primary reason for an older adult accepting the technology at home. The older adult focus group members in the falls alarm trial stated that using a GPS

enabled smartphone app would encourage them to go outside in winter; that they would feel safer and would 'dare' to go out.

5.2.4 Demonstrate that technologies can be convenient

Older adults can be motivated to use technologies by understanding that they can make life easier and overcome some barriers of access to services and venues.

The two studies included in the systematic review, which used technologies to facilitate physical activity at home, found that participants enjoyed being part of a virtual group activity as there were no issues regarding access to venues for classes (Silveira et al., 2013; Wu et al., 2006). It was convenient for them to be part of an activity group, but to do so from home. In addition, stakeholders involved in the consultation reported that older adults had appreciated the convenience of being able to report on their own medical conditions without attending a doctors' surgery. There was also understanding of the fact that technology use can be convenient for care services too, with the example of a medicine dispenser being given. Whilst the older adult enjoyed the visits from care staff to dispense her medication, she appreciated that an automatic dispenser saved her carers time. Additional examples of the convenience brought by technologies included being able to access the internet to read the news in real time; to look for travel information and buy tickets; and to use Skype and email to stay in touch with friends and family. This social element of technology use is addressed in the next recommendation.

5.2.5 Highlight the social benefits of using technologies

Older adults can be motivated to use technologies by understanding how they can help them to communicate and interact with others, staying connected.

Two studies in the systematic review incorporated a social element through the technology used (Silveira et al., 2013; Wu et al., 2006). In the studies that promoted physical activity, participants were able to share experiences, difficulties and opinions with others in the group. They could see each other's progress and were motivated and supported by being part of a group. Many participants in both iterations of the stakeholder consultation reported that the social benefits brought by technology use were a strong motivator for older adults to adopt technologies. Having contact with their families through email, texting, Skype and social media were seen as great benefits in reducing isolation and loneliness. Being able to share pictures with friends and family was also cited as a strong motivator for adopting technology use. Feedback from the usability testing of the exergames showed that multi-player functionality was a motivator for continued play. Participants reported that they would enjoy playing with their spouses, grandchildren, or within a group situation. In addition, stakeholders who had experience of using exergames with older adults reported the importance of the social element of the games; of competing and having fun with others (Nawaz et al., 2014a).

5.2.6 Technology use can increase confidence and improve quality of life

Highlight the possibilities of feeling more confident, increasing skills and the subsequent improvement in quality of life.

Increased confidence was reported by studies in the systematic review (Brownsell & Hawley, 2004; Blythe et al., 2005). In one case, 72% of participants reported feeling more confident after using the technology, which was closely related to their quality of life and sense of independence (Brownsell & Hawley, 2004). In the usability testing of the exergames, one of the reasons given for wanting to play exergames with grandchildren was that it would provide the older adult with the opportunity to demonstrate their skill and, perhaps, to surprise their grandchildren (Nawaz et al., 2014a; Ystmark, 2013). Stakeholders reported that the opportunity to have fun with the games was also a motivator for some older adults, which had the effect of improving their quality of life. In addition, one stakeholder reported a case where a high level support package for an older adult with cognitive impairment had been replaced with various assistive technologies. The reduction in support staff attending the home led to the person feeling more in control and far more confident. Another stakeholder reported that technology use had saved an older adult from regular attendance at the doctor's surgery, which she had found very stressful. Her quality of life had improved dramatically.

5.2.7 The attraction of being challenged by technologies

Ensure that games and applications to promote physical activity involve adequate challenge and progression. Ensure that goals are within reach.

The usability testing of the exergames highlighted the importance of feeling challenged by the game so that it did not become boring. Participants were motivated to continue by being able to master certain levels and move up to the next level. Where this option was not available, participants thought that they would soon lose the motivation to continue playing (Nawaz et al., 2014a;Ystmark, 2013). Goals should be set within reach, without being too easy to attain. High scores were also highlighted as an important element of ensuring motivation to continue. When players were not playing against others, they were keen to beat their own previous high score. The participants were motivated to do better than they did last time. These findings are echoed in the systematic review, where the charting of progress and the importance of improving on previous scores was found. In addition, the importance of feedback on their progress towards meeting their objectives and goals was cited as important (Doyle et al., 2010; Uzor et al., 2012). The importance of attainable goals was also found in the stakeholder consultation. These worked best when they were based upon individuals own needs and aspirations. For example, using an iPad with a Stroke survivor to support them with speech was very successful as the older adult had a strong desire to improve communication with others. The goals should be attainable with reasonable effort, set and tailored to individual needs and preferences. The motivating effect of feedback on performance was also reported in the extended stakeholder consultation and in the falls alarm trial focus groups.

5.2.8 The importance of needing technologies

Ensure that older adults have all the information that they need to understand how technologies could assist them.

Underpinning all of these personal motivations to use technologies is the importance of older adults feeling the need for the technologies; the belief that it will help them. Studies included in the systematic review reported that participants who did not use the available technologies considered themselves not old or ill enough to need them; they would consider using the technologies in the future if they became ill, were at greater risk of falling or lived alone (Londei et al., 2009). These findings were backed up by the stakeholder consultation, with several participants reporting that older adults had only accepted technologies if they perceived a need for it and could see that it would be useful to them. High motivation to use technologies was related to perceived usefulness to the older adult themselves, or to the people around them. This then links back to the importance of clear demonstrations of using technologies and explanations of their potential benefits (Recommendation 5.1.3). Older adults in the falls alarm trial agreed that some of the technologies could be useful, but they did not see an immediate use for them themselves. They stated that part of any training to use technologies must include the reasons for using the technologies and the benefits that they will bring.

5.3 Promoting new interventions to populations and stakeholders

This section is derived primarily from the questions in the stakeholder consultation that focussed on how the FARSEEING technologies might successfully be promoted to older adults, commissioners, service providers and funders (i.e. stakeholders). Whilst the questions specifically related to FARSEEING, the answers provided are applicable to the promotion of any ICT intervention.

5.3.1 Ensure that the technology is affordable

Aim to keep costs at a low level for older adults themselves and provide detailed cost benefits to stakeholders and funders.

Two aspects of ensuring that technologies are affordable were highlighted by stakeholders participating in the consultation. First, low or no costs to the older adult using the technologies was regarded as important. Some older adults had rejected technologies that used their phone lines, as a call was made each time an alert was sent. It was thought that older adults would accept the FARSEEING technologies if they could afford them. Financial assistance for older adults without the means to acquire technologies for communication and security was suggested as a means of encouraging adoption of the technologies. Second, persuading commissioners and funders to adopt technological solutions was regarded by many participants as primarily dependent on a clear demonstration of cost benefits to them. Opportunities to reduce longer term service costs, waiting lists for therapies, reduce hospital and GP appointments and clinics should be explained to funders, with clear cost savings highlighted. These will need to be conducted at a local level, with local funding arrangements for health and social care services taken into account. The outcomes that are made possible by the use of technologies must be explained carefully. In the extended stakeholder consultation, the need to demonstrate how the FARSEEING technologies would be better than

existing systems and devices was highlighted. Leaving existing contractual arrangements may present a barrier for some commissioners and services, so the need to show that they would receive 'more for their money' was thought to be important. As the FARSEEING technologies offer the possibility of fall detection and alert outside of the home environment, this could be a strong driver for adoption. Older adults in the fall alarm trial talked about the increased confidence that they would have to go outside if they were using the FARSEEING technologies rather than the existing push-button pendant alarm.

5.3.2 Appeal to older adults directly in native languages

Make use of opportunities to talk to older adults directly about technologies, so that they can make informed decisions about adopting them.

Several participants in both iterations of the stakeholder consultation focussed on the importance of promoting technologies, and the opportunities that they can bring, directly to older adults. Suggestions included using web portals designed to provide information to older adults; presenting information to them through direct visits, print media and demonstrations; making use of 'word of mouth', where older adults using the technologies talk to others about the simplicity and the benefits of use. Information should be given about the how to use technologies, the benefits or proactive use, the cost and how to obtain the technologies. Stakeholders involved in the consultation and participants in the usability testing of the exergames both stressed the importance of technologies providing instruction in native languages (Nawaz et al., 2014a). This is not only the case for the devices or systems themselves (touchscreen displays), but for websites and written information that describe and promote technology use.

5.3.3 Appeal to the curious

Some older adults are naturally curious about new technologies and could be encouraged to promote technology use to their peers.

Participants in both iterations of the stakeholder consultation highlighted the fact that some older adults are curious about technologies and will 'try anything'. Such people tend to be familiar with technology, using personal computers; smartphones; GPS systems for hiking; and email and Skype to communicate with grandchildren. This natural curiosity about technology can be capitalised upon when introducing new types of technology. Developers can find a receptive audience amongst older users who may be willing to act as champions to promote further uptake of technologies.

5.3.4 Appeal to older adults through existing services and networks

Promoting technologies through trusted services and networks could lead to a higher chance of adoption of technological solutions.

Promoting the FARSEEING technologies through existing health and social care services and networks was suggested by several participants in both iterations of the consultation. General Practitioner surgeries; hospital clinics; therapy, telecare and home care services; voluntary sector organisations and services such

as Age UK were thought to provide good opportunities for promotion to older adults. These services are often highly regarded and trusted by older adults. Suggestions and recommendations for using technologies received from these directions were thought to have a high chance of being taken on board. Specific suggestions included adding the FARSEEING technologies to existing leaflets and brochures about telecare; posters and leaflets in primary and community-based care facilities; people working in care services giving presentations to older adults using their services. In addition, stakeholders in the extended consultation highlighted the opportunity for family members to encourage adoption; they know the older adult well and can key into a potential motivation to use technologies.

5.3.5 Focus on the positive

Demonstrate examples of success in technology use and use positive language to encourage adoption.

Participants in the usability testing for the exergames reported that positive encouragement to use the games would be more likely to lead to successful uptake than negative reasoning (Nawaz et al., 2014a). Telling older adults that they need to use exergames because they are overweight and unfit was thought to be unlikely to encourage adoption. Recommendations from physiotherapists were regarded more positively, provided the focus was on the positive outcomes made possible through technology use. Stakeholders in the consultation recommended that examples of success be shown to older adults, demonstrating how use of technologies had led to good outcomes for people.

5.3.6 Find the local relevance

Identify local ‘gatekeepers’ and the opportunities for funding technologies in each area. Tailor promotion of technologies to local opportunities and needs.

The stakeholder consultation highlighted the differences between countries (and regions within countries) regarding possibilities for funding and adopting technology use. Whilst some commissioners were reported to be promoting technology use positively, others were uncommitted or unable to find the means to fund such interventions. As such, it is important to understand the local situation when promoting the adoption of technological solutions. Each region, locality, organisation or service will have ‘gatekeepers’ who must be convinced of the opportunities brought through technology use. Those promoting technology use should identify and form relationships with these gatekeepers. It is important to understand that each area, commissioning body and organisation will have their own priorities for action and spending, which must be taken into account and understood. We should try and reflect the local commissioners’ and funders’ need for solutions. In promoting technologies, we should understand where organisations and services are looking to make savings and think about how the technologies can help to achieve those savings. In addition, stakeholders in the consultation suggested promoting the potential benefits of technologies to frontline staff, who can promote them within their own organisations (e.g. Social Workers, Assessors and Home Care workers).

5.3.7 Find a local champion

Recruiting an older adult, or a respected clinician in a position of influence, to promote the benefits of technological solutions could facilitate implementation of interventions.

Participants in the stakeholder consultation expressed the view that knowledge of the local situation with regard to funding and implementation opportunities would be complemented by having local 'champions' for technology adoption. This could be an older adult, as in the case of recommendation 5.3.3, or clinical champions who should be supported to promote technologies within their organisations, areas or regions. If these champions were also in the positions of gatekeepers, opportunities for the uptake of technological solutions could be maximised. An additional suggestion from the stakeholder consultation was to involve stakeholders in trials of new technologies. For example, working with an existing falls prevention team to try out new technologies, as they are already receptive to ideas and interventions to prevent falls and could advocate the use of new technologies.

5.3.8 Demonstrate older adults' acceptance of the interventions

Studies and implementation trails should report the views of older adults with regard to usability and acceptance of technologies.

In addition to the importance of demonstrating an economic case for adopting technological interventions (recommendation 5.3.1) stakeholders stressed the importance of demonstrating that technologies had been accepted for use by older adults. Research studies should include usability testing and implementation tests that report on the experience of older adults using the technologies. Successful adoption will rely upon appealing, easy to use equipment as well as technologies that are affordable. The results of the TSQ-WT Satisfaction Questionnaire, reported in the FARSEEING deliverable D4.4 ('Preliminary report on the information collected with the Smartphone technology') and which focussed on benefit, usability and wearing comfort, showed that the 96 participants monitored for 7 days rated comfort and ease of use highly. On a Likert scale of 1-5, 'Wearing this device is comfortable' was scored at 3.77$\pm$ 1.39 and 'This technology is easy to use' was scored at 4.88$\pm$ 0.43. Evidence-based case studies, demonstrating real results such as these, have a powerful role to play in promoting the uptake of technological interventions.

5.3.9 Demonstrate sound, peer-reviewed research

Promotion of successful trials of technology use should be reported in academic circles, to facilitate the adoption of evidence-based interventions.

Several stakeholders in both iterations of the consultation stressed the importance of publishing the results of usability tests and implementation trials in peer-reviewed papers. Organisations and services need to see the evidence supporting the advocation of a particular technological solution. Tests and trails should be reported at conferences and existing academic networks. It was thought that the technologies should be tested with large numbers of older adults in order for the feedback received from them to have statistical significance.

5.3.10 Promote the interventions at conferences, fairs, conventions, through existing networks.

Promotion of successful trials of technology use should be reported in business and industrial circles to raise awareness of available solutions.

In addition to the promotion of ICT interventions within academic circles and networks, stakeholders involved in the consultation stated the importance of promotion within business and industrial networks. In particular, it was suggested that the non-academic partners of the FARSEEING consortium should present and promote the FARSEEING technologies at trade fairs, conventions and commercially oriented events. The possibility to integrate new technologies into existing product portfolios was thought to be an important driver for uptake by businesses.

6. Updating the recommendations

Each of the recommendations presented in this document has been drawn from participants in one or more of the five FARSEEING research studies. At the point of writing this update to the guidelines, there is one further FARSEEING study still analysing data regarding user feedback. This is the pilot testing of the smartphone and smart home complex intervention in work package seven (WP7). As such, these recommendations will be reviewed and updated to incorporate the results from this study. Feedback from participants using the FARSEEING technologies will be incorporated into an updated version of these guidelines which will be released via the FARSEEING project website at the end of the project (April 2015).

7. Conclusion

These guidelines have been produced as part of work package two of the FARSEEING project. The central aim of this work package has been to identify users' perceptions about available and emerging technological solutions for 'ageing well', aimed both to monitor and reduce the risk of falls and to improve independent living. Our intention has been to identify the perceived advantages and disadvantages, as far as possible based on users' experience, when using such technologies and to provide evidence-based guidance. We undertook to understand more about what technologies are acceptable, what is likely to be used by older adults, and how technologies are used. We have also been concerned with maximising uptake and adherence through older adults being involved in the development of technological interventions.

To achieve our aim, we have synthesised the findings of the FARSEEING studies which have reported user feedback, older adults' and stakeholders' views, to develop guidelines for best practice in developing and implementing ICT technologies in the area of fall prevention and the promotion of independent living. These guidelines present easily accessible (non-technical) recommendations, aimed at scientists, clinicians, technologists, manufacturers etc., which outline the principles for making ICT technologies acceptable to older adults. The principles which underpin the recommendations presented her are that technologies must be easy to use and person- or user-centred, enabling users to maintain the highest possible quality of life. The recommendations have been presented under three overarching headings: usability and design issues; personal motivations; and promoting new interventions to populations and stakeholders.

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Appendix 1 Stakeholder consultation questions (UMAN)

From these discussions, we want to learn from the experiences of the various stakeholders and then think about how receptive older people will be to what FARSEEING is developing and proposing to implement. We have some 'starter questions' to get the discussions going, but the follow up questions will depend on the responses that participants give. Some general prompts are included and will be used to prompt and probe further, to generate more discussion.

General technologies

1. Can you tell us about your experiences of using ICT (Information Communication Technologies) with older people?
2. How receptive have older people been to using these technologies?
   e.g. smartphones, personal computers, tablets, health or care related technologies.
3. What issues and barriers have you come across?

Falls / independence specific technologies

4. Can you tell us about your experiences of using ICT with older people that promotes independent living and / or is intended to prevent and detect falls? *e.g. falls detectors, sensors or cameras in the home, games consoles that run exercise games.*
5. Can you tell us what the barriers and opportunities are to using technology with older people in the place where you work?
   e.g. will the health services fund technologies? Are commissioners positive towards using them?

FARSEEING technologies

The FARSEEING technologies include:

- a falls detector built into a mobile phone that is worn on a waist band,
  a home automation system that connects to the smartphone, which also enables
- users to set goals and encourages them to exercise by showing them daily exercises. The system provides prompts for users to walk and self-assess their progress. The system provides motivational feedback on progress and encouragement to continue.
- the Silverfit game will link with the system to provide exercises for the users. Information and demonstrations of Silverfit can be seen at http://www.silverfit.nl/index.php

6. What do you think the benefits are of the technologies and interventions developed as part of the FARSEEING project?

7. What should the FARSEEING project do to engage better with older adults and with stakeholders?

Suggested prompts

Can you tell us a bit more about that?
Why do you think that was the case? Has anyone had a similar experience? Has anyone had a different experience?

Appendix 2 Search strategy for systematic review (UMAN)

Aging Population/ patients	**ICT Interventions/Applications/ Technologies**		**Study design****	***Outcomes***
Target population: 65 and over 80 and over Aged Alzheimer disease Dementia Disabled elderly mentally infirm Elders/Elderly Extra Care Frail Geriatrics Older Seniors Assisted-living facilities Care facilities Care homes Community care facilities Convalescent homes Long term care Nursing homes Residential Homes Rest homes Retirement communities Sheltered housing Community home* In-home* communit* Independent living Primary care	**Interventions / Applications:** Activity monitoring Alert system Ambient assisted living Assistive technology Computer assisted computerised reminder$ ehealth or e-health elearning e-learning Environmental Fall alarm Home alarm Home automation Home Care Home control home healthcare home nursing home-based intervention home-telecare intervention network home care hospital at home Information Services in-home interactive Intelligent Environment internet-based intervention Computerized Monitoring Patient Identification Systems Pda Personal care Personal digital Assistant Personal protection phone-based intervention Reminder system Computer assisted Identification systems Reminder Systems Remote consultation remote consultation$	Cell phone cell-phone cellular phone communication network$ communication technolgogy Computer Systems Computer$ Databases Detection Detectors Education technology Persuasive technology Electrical electronic communication electronic mail email e-mail Fall detector Gyroscope Headphone Headset Ict informatics information communication technolog$ interactive multimedia interactive technology internet Keyboard Local Area Networks Medical Informatics Applications Memory card Microphone Mobile Mobile computer mobile phone mobile phone text messag$ Mouse Notebook on-line online medical record Remote communication$ Sensor Smart phone	“before and after” Case Studies Clinical trial Comparative stud$ Control Studies Controlled before Controlled clinical trial Cross sectional Double Blind$ Evaluation Evaluation stud$ Interrupted time$ Intervention stud$ Intervention$ Post Test$ Posttest$ Pre post$ Pre test$ Prepost$ Pretest$ Program evaluation Qualitative Quasi-experiments Random allocation Random$ Randomized controlled trial RCT Time serie$	*Adherence* *Attitudes* *Autonomy* *Behaviour* *Beliefs/views* *information* *Exercise* *Falls Fractures* *Function Health* *Independence* *Movement* *Physical activity* *Skills behaviour* *Uptake* *Preference* *Usability*

Aging Population/ patients	ICT Interventions/Applications/ Technologies		Study design**	*Outcomes*
	Remote consultation$ Telecare tele-care home Telehealth tele-health telehome-care program Telemedicine Tele-medicine telenursing tele-nursing telephone intervention Tele-rehabilitation videophone intervention web health web-based intervention Specific Technologies: Accelerometer Alarm button Audio Visual Camera	Smart Technology Tablet computer telecommunicat$ Tele-monitor Telemonitor$ Touchscreen video $ videophone video-phone virtual web site* website Wireless communication Wireless phone world wide web www		

** Study design search terms were not used in the searches, so not to narrow the search

Systematic searches undertaken of MEDLINE, EMBASE, CINAHL and PsychINFO. We also undertook a systematic search of the engineering database, COMPENDEX and the Cochrane database. No date restrictions were placed on the search and all relevant evidence was included if in the English language. Search terms were both free-text and MESH headings and were combined with Boolean operators. Key search terms included ‘older adults’, ‘seniors’, ‘preference’, ‘attitudes’ and a wide range of technologies (see above) they also included the key word ‚fall*‘. The electronic searches are up to date at 01 April 2013.

Appendix 3 Usability testing questions (NTNU)

Questions from the usability testing of the exergames:

Performance Expectancy
To measure the perceived performance of these games, questions were asked about how do the participants feel that these games can be useful in terms of exercise.

- What game did you feel would be most efficient when it comes to exercise? Why?
- Would a game like this fit into your everyday exercise routines? Why or why not?
- Could any of these games be useful for you? If so, in what way?

Effort Expectancy
The questions related to effort expectancy were based on the participants ease of use of the games and how they compared to each other.

- What game was the easiest to use? Why?
- Which game was the most complicated? Why
- Did you have problems understanding how to use the game or read what was on the screen? What gave you problems?
- Did you understand the feedback you were given?
- Did the feedback you got, match your movements?

Social Influence
How does social factors contribute to the participants potential use of the games?

- Would you feel embarrassed or uncomfortable telling your friends/family that you play these games?
- Do you think you could use these games in a social setting?

Facilitating conditions
Measuring in what way the home environment affects the participants future use of the games, the questions relating to facilitating conditions are concerned with the potential of a home use situation only.

- Would you have room for this equipment at home?

Behavioral Intention
The questions concerning behavioral intention are designed to measure if the participants actually intend to use the system.

- If you had any of these games at home, would you play them regularly?
- What game would be your first choice?

Self-efficiency
The construct of self-efficiency concerns the participants perceptions that he/she will be able to use the games by him/herself.

- Do you think you could use these games by yourself?

Anxiety
These questions measured if the participants experienced any negative feelings during gameplay.

- Did you ever feel anxious or nervous playing the games?
- Would you feel anxious playing these games at home?

Attitude towards technology
To measure the participants attitude towards technology, questions were de- signed to capture the participants motivational factors to use the game. The concept of fun was introduced.

- What do you think about playing these types of games?
- What game was the most fun? Least fun? Why?
- What elements of the game could motivate you to keep using it in the future?
- How do you picture a game like this should be if you would use it in your everyday life?

Safety
Due to the fact that the context of use of these games is to train the users balance, the construct of safety was added. This was to measure the participants perceived risk of falling or injuring themselves during the game.

- After being here for this session, do you think you would be able to use these games at home and feel safe?
- Were you ever afraid of falling while playing any of the games? Any one more than another?
- Did you feel in control of your movements while playing the games?

Questions from the usability testing of the FARSEEING touchscreen interface

Participants were asked to evaluation of the system on a scale (1= Strongly disagree, 2= disagree, 3 = neutral, 4 = agree, 5= strongly agree) with regard to the following statements:

- This system will help me stay in shape.
- This system is simple to use in home.
- System is motivating and fun.
- I will tell my family and friends that I use this system.
- I will set up this system in home.
- I will prioritize to buy this system even if it costs much.
- I will be able to use this system on my own.
- It seems not difficult to use this system.
- I will use it in near future (soon).
- The system fits with other seniors as well.

Appendix 4 Focus group questions and themes (NTNU)

Focus group themes and questions with healthcare professionals

Information about fall risk

- What are most important types of information to collect in fall risk assessment?
- How do you use the different pieces of information to make a judgment about choice of intervention?

Physical activity and fall risk assessment

- Most falls are experienced during walking and other daily life activities. It is now possible to monitor these movements with small body worn sensors, or even smart phones. We work with identifying physical activities and fall risk activities in seniors based on information from such sensors. Would such information be of importance for your assessment and clinical decision-making?
- In your view, what do you see as the advantage of seeing physical activity data of seniors?
- Do you think that providing seniors information regarding their physical activities would make seniors physical more activities?
- In your view which are those physical activities that are important for falling and assessment of falling?

Technology and presentation of physical activity data

- Regarding presentation of physical activity data, how would you like to see physical activity data presented? Should it be figures or text ? Can you give an example ?
- For healthcare professionals, what would be more appropriate technology to see information regarding seniors physical activity data? e.g. Computer, Ipad, smartphone

Communication of information to the older person

- Do you think the feedback on seniors physical activities will motivate them to be more active?
- Do you think that that providing information to the older person about high fall risk activities would help the person to avoid those activities ? can you explain
- How do you think the older person will react if receiving information about activities to avoid fall ? Do you think that it would make them inactive and increase fear for falling?
- In your clinical practice: Would you be willing to spend some time registering information fall risk to be used for the older person?

Solution for collecting information about fall risk

- In order to collect reliable information about falls and fall risk from body worn sensors, the sensors have to be closely connected to the body.
- We have developed a system to gather information about fall risk and detect falls that happen. Please wear it on your back?
- What do you think about this system?
- Which other solutions do you see that could have improved feasibility of fall risk

Focus group themes and questions with elderly citizens (Norwegian)

Fysisk aktivitet i dagliglivet

- Er du bekymret for mengden fysisk aktiv du er i løpet av en dag og/eller en uke? Med fysisk aktivitet mener vi alt fra daglige gjøremål i hjemmet til faste treningsøkter.
- Hvis du er bekymret, hvorfor?
- I forhold til fysisk aktivitet, hvor mye sammenligner du deg med venner/bekjente?

Informasjon om fysisk aktivitet som kan deles med helsepersonell

Note: Vi vil gi informasjon og eksempler før vi stiller spørsmål

- Vil du ha informasjon om ditt aktivitetsnivå fra lege eller fysioterapeut? Hvilken type informasjon ønsker du i så fall?
- Tror du at informasjon om ditt aktivitetsnivå vil gjøre at du blir mer aktiv? Hvorfor/hvorfor ikke?
- Vil du ha kort og direkte informasjon eller ønsker du lengre informasjon med mer forklaring? Hadde du foretrukket grafer/figurer eller tekst? Har du eksempel på hvordan du ønsker informasjon?
- Hvordan ville du følt det dersom helsepersonell kontakter deg I forhold til oppfølging av din fysiske aktivitet?

Undersøke fysisk aktivitet

- Hvis du fikk forespørsel om å ha på en sensor som detekterer fysisk aktivite, hvor på kroppen ville du helst hatt denne sensoren? (demonstrere muligheter)
- Når ville du ikke vært komfortabel med å bruke en slik sensor?
- Prøve på vår sensor/smartphone.
- Hva synes du om dette systemet?
- Hadde du trengt hjelp/assistanse hvis du skulle brukt en slik sensor?

Behavioral Intention control:

- Hvordan ville du reagert hvis din fastlege hadde sagt at du matte ha på deg en sensor for å overvåke din fysiske aktivitet?
- Hvordan ville du reagert om informasjonen om ditt aktivitetsnivå kunne bli studert av legen?
- Hvordan ville du reagert om informasjonen om ditt aktivitetsnivå kunne bli studert av familie og/eller venner?
- Kunne du vært interessert i å brukt mobil telefon for å detektere ditt aktivitetsnivå?
- Ville du vært interessert i å skrive inn din daglige aktivitet på en mobil telefon eller pc?

Fall relatert

- Hvordan ville du foretrukket å bli kontaktet hvis din mobil telefon har oppdaget et fall?
- Har du tidligere mottatt råd/informasjon fra din lege om fall og fallrisiko? Hvordan opplevde du dette?