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ACANTO

A CyberphysicAl social NeTwOrk using robot friends

Deliverable 1.7

User requirements refinement report

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Executive Summary

Background

This report describes in detail the process of refining the initial requirements reported in D1.6 (User requirements). That document described the high-level user requirements generated in part from previous DALi requirements (a similar, previous project) and requirements elicited from users as they talked about the kinds of activities they engaged in during daily life (reported in D1.3). Because we were placing the interests and experience of the user at the centre of our design, understanding the types of activities that older adults typically engage in was essential to understand the requirements of a system that would be able to recommend enjoyable activities. Based on those discussions with potential users, we developed a series of scenarios where our technology (the FriTab and FriWalk) could be used to enhance and support these activities.

Alongside this more activity-based focus, we worked with clinicians to develop a set of requirements and scenarios that would enable the FriWalk and FriTab to be used during rehabilitation in a variety of care-contexts. With the goal of such a system being to facilitate the re-engagement of patients into everyday life, the use of the FriWalk to provide the link between rehabilitation support and everyday activity support was deemed to be important. Patients who used the FriWalk system during rehabilitation could also find a similar FriWalk when they went to their local shopping mall or museum. This would enable them to continue to enjoy the support of the system and to provide enhanced enjoyment of their activities through the various features of the FriWalk.

The team then used the scenarios to generate a list of requirements the system would be required to meet in order to deliver those scenarios.

Scenarios and requirements elicitation

After D1.6 was produced (a revision of which is underway to elaborate on the process of generating these requirements), the scenarios had not yet been replayed to users to see how they would respond to the envisaged system. The process of using scenarios to generate requirements is well-established (Sutcliffe, 2003) and in this case, we used the scenarios to test and refine the requirements. As users watched the scenarios, they were invited to comment on features that they liked, disliked or would like to see improved. They were also asked to comment on whether they would see themselves or a friend using the system.

This process worked very effectively and was conducted in four contexts. In the first context, UNAN conducted interviews where they showed video-animations of the scenarios to older-adult participants in the UK. In the second, Getafe Hospital (HUG) presented video-animations of the scenarios to clinicians to get their feedback on the rehabilitation aspects of the system. In the third, HUG presented the same animations to older-adult patients to get their feedback on what they liked and disliked about the system. Lastly the clinical team were presented with a new prototype of the walker to fully understand what it was capable of. This allowed a full review of all requirements in order to understand what needed to be refined.

As a result of the scenario changes, and the review of the prototype, the requirements were updated and reviewed by the relevant teams to guide their developments.

UK requirements refinement (general and social use)

In the UK, 23 participants were recruited (mean age 73) who watched animations chosen by them based on their similarity to themselves or a friend. After watching the scenario, participants were asked about their views on what they liked or disliked about the scenario. Their answers provided insight into how the requirements should be refined. The issues raised by participants are summarised briefly below, organised by scenario. While the requirements are not specified here, they can be fully reviewed in Appendix 3. For each issue raised by participants, a relevant requirement was implemented or refined. For positive comments (i.e. belief that the system was useful and helpful), these confirmed existing requirements.

Scenario 1: Older user using FriTab
Participants were worried that the recommendations could become annoying if they were too frequent. Users with poor eyesight worried about how they would see the screen. The main objection was that the scenario matched people (miners) who already have support networks. Requirements were made to address these issues.

Scenario 2: Using FriWalk features (matched pace)
Participants worried about technology difficulty of use. They were concerned that they might be paired with incompatible others. They also worried about how to solve problems that might arise if an error occurred. They did not like the idea of being forced to keep pace with a slower user.

Scenario 3: Using FriTab
People who are afraid of falling might not use the system, said some. Others noted that the weather can stop people from accepting recommendations. Still another said that people might want to bring their spouse to events.

Scenario 4: Co-ordinating activities
It was noted that internet access would be necessary. The financial cost of activities should also be flagged to users. Participants were not sure whether there should be an age limit. They were also concerned that users should be vetted in some way.

Scenario 5: FriTab and FriWalk integration for museums
Participants mentioned the need for a seat and for transport information to get to the museum. They wanted the FriWalk to be sturdy.

Scenario 6: FriTab and FriWalk integration for shopping
Participants worried that places sometimes changed names so a navigation system that provided consistent naming would be useful. The FriWalk should also have a basket for some shopping. It should be height adjustable and slim enough to use in shops. It should be easy to manoeuvre.

Scenario 7: Older user in decline and doctor notification
Participants may not want to share all information with a doctor.

Scenario 8: Intergenerational contact
Email or video calling prior to meeting face to face would be useful. People would want to know in advance whether the group they were meeting was of mixed age groups.

Scenario 9: Non-personal FriTab and FriWalk
Not all participants wanted navigation prompts. Some users wanted haptic feedback. They liked the idea of the FriWalk being able to avoid obstacles and people.

Scenario 14: Rehabilitation and activity integration
The system should take the confidence levels of the user into account when suggesting to go out. It could gradually build up confidence by increasing the level of its suggestions.

These issues and suggestions were translated into requirements. Subsequently, these requirements were shared with developers and feedback was provided. This led to an expansion of Appendix 3 in which some requirements were rejected based on project limitations (time and technology) and some were refined.

Spain requirements refinement (rehabilitation use)

In HUG, a similar process was followed to the above. Firstly, a focus group with clinicians was conducted (9 professionals). What follows is a short summary of the issues raised for each scenario.

Scenario 10: Rehabilitation and social use
The patient's home may not be ideal for FriWalk use. The home would need to be assessed first. Rehabilitation should also be supervised in the early stages. The FriWalk should also have an emergency button.

Scenario 11: Functional decline (Revised: adjustment disorder)
Concerns were raised about the delegation of responsibility: the persons responsible for care should be the nursing home staff.

Scenario 12: Rehabilitation after hip fracture
The responsibility for care needs to be clear. The walker should be seen as a temporary rehabilitation measure.

Scenario 13: Rehabilitation tracking
Again, delegation of responsibility for care needs to be clear. The nursing home staff are ultimately responsible and the geriatrician at the hospital can act as a consultant.

Scenario 15: Diagnostic tool
Concerns were raised about how the FriWalk could inadvertently alter the gait of the user if it is in front of them.

Again, at HUG, another focus group was carried out with 8 older adults who discussed the rehabilitation uses of the system. This focus group raised issues around navigation for people with visual deficits and made some suggestions about the outdoor use of the FriWalk and how it could be used to navigate outdoor environments. They proposed that it should have an alarm button to emergencies and it should have a basket to help them carry things around.

Functional requirement specification for clinical use

Having arrived at these clinical requirements, the project team met in Madrid in September 2016 to discuss how to implement these and to demonstrate the latest prototype. This is more fully reported in section 5 of this report. The discussion revolved around implementing diagnostic and exercise functionality. It was agreed to implement the SPPB test (Short physical performance battery; a widely used diagnostic tool). This involves a test for balance, gait, and a chair sit-up, sit-down test. Orthogeriatric exercises were also discussed including:

- an exercise to walk x minutes per hour,
- exercises involving holding one's leg extended for a specified number of times,
- a stand-up stand-down exercise,
- an exercise to walk x metres per day at y m/s,
- an exercise to stand on one leg, and an exercise for standing on tiptoes.

Summary and future work

Overall, this report shows how the requirements have been refined and tested with users, how they have been translated into new requirements, and how the clinical requirements have been moved to a lower level with the functional requirements given for the diagnostic and orthogeriatric exercises. This report provides the basis for future work by identifying the requirements that need to be met by developers (pending still further discussion about their feasibility) and by validating the core idea of the system with users so that it can be seen that this is a system which is valued by both clinical and general users. The requirements spreadsheet is now a shared document which the team use as they translate the requirements into a more detailed design.

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1 Introduction

The overall aim of the ACANTO project is to increase the number of older adults who engage in regular and sustained physical and social activity. Physical activity is known to have numerous health benefits thoughout the lifespan (Warburton, Nicol, & Bredin, 2006) and for older adults, higher levels of physical activity are associated with reduced risk of depression (Strawbridge, Deleger, Roberts, & Kaplan, 2002), increased cognitive performance (Colcombe & Kramer, 2003) and increased quality of life (Drewnowski & Evans, 2001). Also, by regaining and/or maintaining activity levels we hope to reduce the possibility of future falls. Social engagement is another important influence on the health of older adults and recent research has highlighted that social factors are vitally important in maintain the health of older adults (Greaves, Colin, J, .and Farbus, 2006). While people who are socially isolated are not necessarily lonely, those older adults who are lonely face pose significant health risk (Alpass & Neville, 2003; Cornwell & Waite, 2009) and even increased mortality risk (Luo, Hawkley, Waite, & Cacioppo, 2012). By encouraging combined social and physical activity, we aim to improve the wellbeing of older adult users. Tackling both issues together is important because depression (for example) is linked to both social isolation and physical inactivity and by addressing both issues, there may be a higher chance of success.

The solution will be targeted at people who are at risk of not maintaining an active lifestyle because of i) a fall or illness that has left them in need of rehabilitation or ii) lack of friends, awareness of activities they can be involved with, or lack of motivation has resulted in less social and physical activity.

There are two distinct contexts of use – within a hospital or care home under medical guidance and within a home environment and public areas, without medical supervision, for those living (semi) independently who would benefit from increasing their daily activities.

The users primarily targeted are older adults above 65 years of age with the following characteristics

- Mobility impairments requiring the user to recover their mobility
- Older adults whose social and physical activities are at risk of decline

However, secondary users are

- Medical practitioners responsible for the welfare of the older adults including clinicians managing the rehabilitation and GPs.
- Care home staff responsible for the welfare of their residents
- Informal carers responsible for the welfare of their relatives
- Mangers of museums, shopping centres and other public places who are willing to offer the service to their customers

It is thought that ACANTO will achieve its aim via the following system design goals:

From a social/physical perspective

1. Collect physical observations of users' activities that can be used as indications of health, habits, preferences.
2. Maintain a profile of user health, interests, social circles
3. Create social circles of users with similar profiles
4. Generate and recommend activities to different circles of users
5. Supervise execution of activities and collect data on the satisfaction of users involved

From a prevention perspective:

1. Encourage users to be more physically active in order to maintain wellbeing
2. Encourage users to be active and conduct exercises in order to reduce risk of falls

From a rehabilitation perspective

1. Support the rehabilitation of patients after a period of reduced mobility due to illness or a fall.
2. Provide a diagnostic tool to monitor progress of patients receiving rehabilitation.

This deliverable is dedicated to understanding requirements from the user perspective, and gathering those requirements via a set of user-centred activities.

1.1 Our approach

We have based our method on a requirements approach, which uses scenarios and prototypes to elicit requirements. It starts from the point where system design goals are specified as these formed part of the project specification. It takes these goals and develops requirements from the end-user's point of view, documented as scenarios.

Our approach is supported by a set of data collection activities for establishing user requirements, which are also described within this document.

We have adopted a user-centred approach to requirements engineering, based on scenarios and early prototype evaluation. Methods for scenario based requirements engineering have an extensive history. (e.g. Potts, 1995; Sutcliffe, 2003). By using scenarios and early prototypes, the research team can contextualise the detailed requirements necessary in order to fulfil the desired aim of the system in the real world.

Why task scenarios?

Task scenarios document how the users and stakeholders will interact with the new system in order to achieve their task goal. Thus people will be able to understand what the system will be able to do for them when it is complete. It also ensures that the complete task is considered, which may highlight problems that would not be noticed if dealing with the individual functions from an early stage.

This approach allows us to identify high level user requirements (and associated constraints) and obtain feedback prior to more detailed technical requirements being finalised. This puts the emphasis on understanding detailed scenarios of use in order to i) elicit important non-functional requirements, ii) explore the system as a whole and iii) to ensure that potential problem areas are not overlooked. This in turn helps prioritise requirements from a user perspective

In Deliverable 1.6 we presented the initial requirements for ACANTO. These requirements were based on a study where we identified the activities older adults enjoy engaging with and examined the barriers and motivators to socio-physical activity for older adults. Using the Integrated Behaviour Model, we explored how attitudes, norms and efficacy beliefs affected older adults' willingness to engage in everyday social and physical activities. Using the information from that report and our ideas of the proposed social-physical aspects of the ACANTO system, we produced a series of personas and scenarios that described how the system would be used to perform various tasks such as helping people around unfamiliar shopping centres or encouraging an older adult to join an acting group. The rehabilitation requirements were based on scenarios created by Getafe hospital after working with patients and clinicians.

From these scenarios, the team generated system requirements in addition to those the requirements identified in a previous project (Devices for Assisted Living; DALi)[1], The idea being that to provide the scenario document, those requirements should be met. These outputs formed Deliverable 1.6 which identified the initial scenarios and user requirements that would then be re-evaluated in the refinements phase.

For the refinement phase, these scenarios were converted into animated storyboards and working prototypes of the robotic walker, which were used in the refinement activities documented in this report. The four activities have contributed to the refinement of the requirements are:

1. Interviews with older adults about the non-clinical/social use of the system
2. A focus group with clinicians at Getafe
3. A focus group with older adults undergoing rehabilitation
4. A workshop between the project team and clinicians in Getafe

[1] DALi was an EC funded project that built an assisted walker for older adults to enable navigation around indoor spaces such as shopping centres. The walker from that project formed the basis for the ACANTO walker, the FriWalk.

The refined requirements are presented in appendix 3 and will be managed as a live document as the project progresses.

1.2 Process and relationship to other work packages

The generation, testing and refinement of requirements happens in close relation to other parts of the project. In Figure 1 below, we show the process by which requirements are generated, refined and tested. At the top of the diagram, the scenarios mark the point where the requirements are generated by considering what is needed to enable the system to function as the scenarios describe. These scenarios feed into requirements (on the right) and evaluation (on the left). The latter is where the scenarios are tested through presenting them to various users and asking for feedback. The requirements then feed into the prototype development in which developers seek to achieve the requirements specified. At various stages in the diagram, bi-directional arrows indicate that the flow of information goes both ways. For example, evaluation of scenarios feeds back into the redesign of some of those scenarios. Likewise, the requirements are not only generated by scenarios, but also help to define and refine some of the scenarios. So throughout the system development, there is constant transfer of information to ensure that all parts of the project progress in unison.

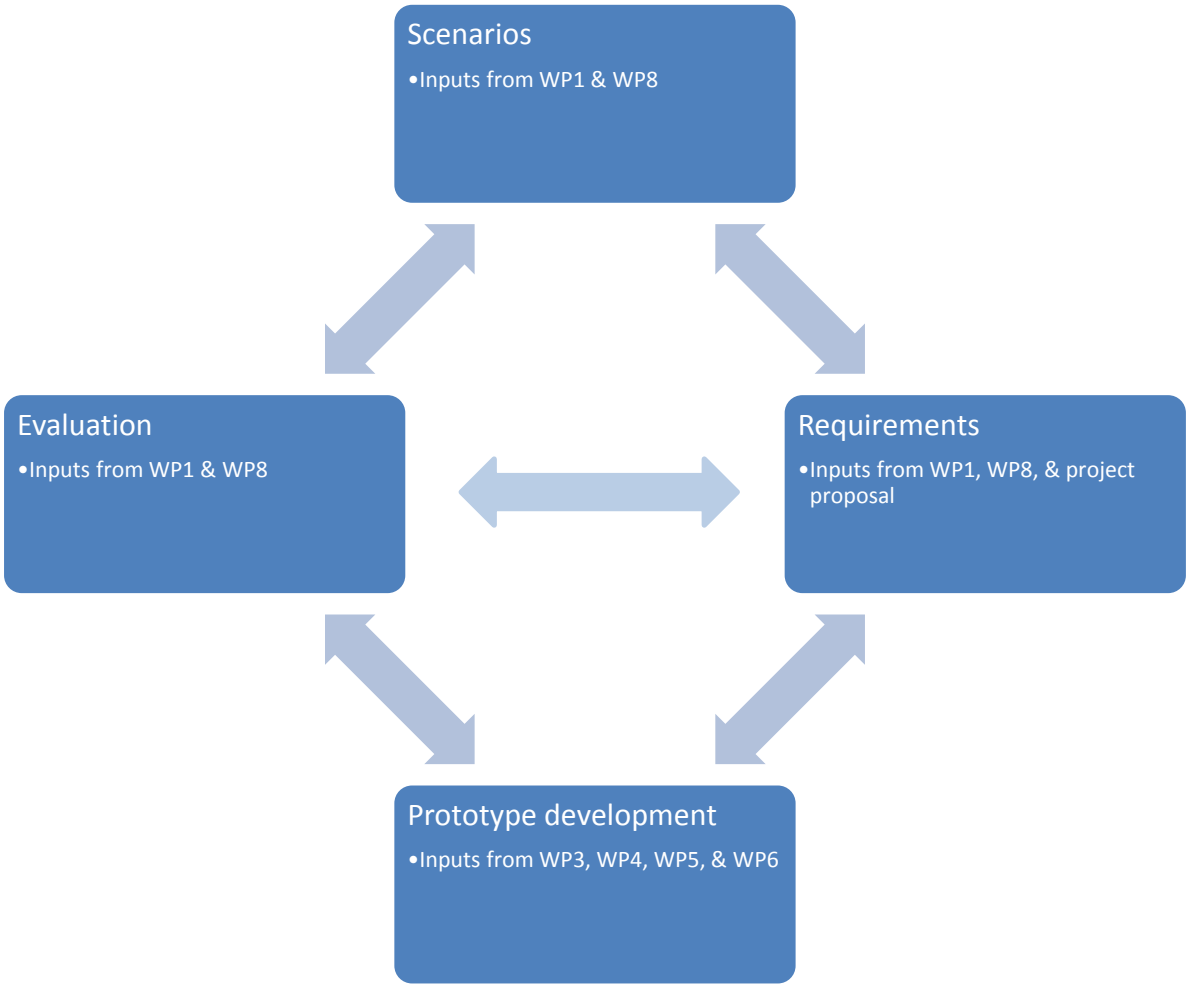

Figure 1: Process diagram for system development

2 User interviews for non-clinical use

Having produced the 14 different scenarios and their requirements, it was necessary for us to test these with potential users in order to see whether they would be appealing to them. In the absence of a working system to test in the early stages of development, using the scenarios helps potential users to envisage how they might use the system in their daily lives and the facilitators and barriers that they might face. We not only asked users about how the system might suit themselves, but also how it might be useful for friends or relatives.

Getting this feedback from users enabled us to modify the requirements in line with their suggestions and the approach and results are described below. By doing this, we have placed the desires of users at the centre of the design process.

2.1 Method

Participants

23 participants were recruited from the North East of England via email and telephone. All participants were from the UK (13 females, 10 males; age ranging from 60 to 89, mean 73). Participants were all given £10 to cover travel expenses.

Materials

For the interviews with the participants, there were three sets of materials: the scenarios, the descriptions of scenario personas, and the interview questions to explore the views of participants.

To test the scenarios with users, we produced short animations (approximately 2 minutes long) that described the scenarios. Using animations helped the users to engage more with the scenarios and several participants remarked that they enjoyed watching them. The scenarios are available online at this location: https://goo.gl/XXz1La. A still frame from an animation is shown in Figure 2 below.

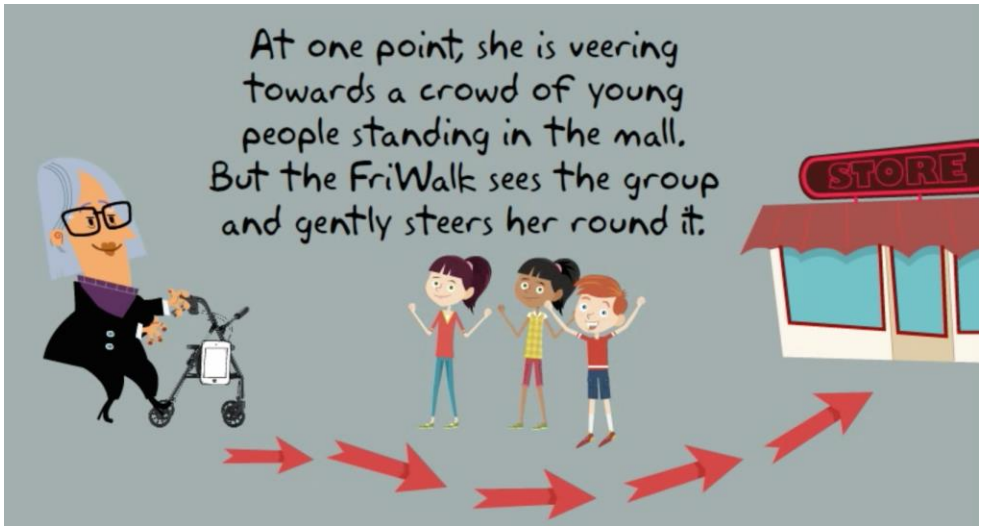

Figure 2: Still frame from scenario animations

Participants selected 3-4 scenarios to view based on their (or a friend's) similarity to the personas described on small cards that were given to the participants to sort. The list of descriptions is given in Table 1 below.

Table 1: Descriptions of personas given to participants

Number	Description of personas
1	**Anthony** is a 75-year-old man who lives alone. He lives in sheltered housing near Gateshead town centre. He lives a quiet life and doesn't get out much. Two or three times a week he walks to the local superstore to buy groceries.
2	**Isabel** is an 82-year-old woman who has lived alone for the past two years. She lives in a flat by herself in Newcastle. She no longer goes out very often and has become very physically inactive. Her daughter brings her groceries once a week.
3	**Sarah** is a 72-year-old woman who lives with her husband. She lives in a small house in Corbridge. Sarah enjoys living in the rural community and has a small number of friends who live nearby.
4	**Tom** is a 68-year-old man who lives with his wife. Tom lives in Byker, Newcastle. Tom has quite an active social life and enjoys meeting new people.
5	**Michael** is a 72-year-old man who lives alone. Michael lives in Felling, Gateshead. For the past few years, he has found mobility very difficult and he is waiting for a hip operation. Consequently, he doesn't get out much.
6	**Dorothy** is a 69-year-old woman who lives alone. She lives in Blaydon. Dorothy uses a walker to get around because she finds that it gives her confidence after her fall one year ago.
7	**Fatima** is a 73-year-old lady who lives with her husband. She lives in Hexham. She is reasonably active and enjoys using her walker to help her get around.
8	**George** is an 81-year-old man who lives alone. He lives in Newcastle. George is quite active and enjoys helping others.
9	**Isabella** is an 89-year-old woman who lives alone. She lives in Newcastle City Centre. She is not as active as she used to be because her eyesight is getting worse and she worries about losing her way.
10	**Manuel** is a 74-year-old man who lives alone. He lives in an apartment in Madrid. He recently suffered a bad fall which has made it difficult for him to get around. He is undergoing therapy at a local falls clinic and is slowly getting better.
11	**Manuela** is an 83-year-old woman who lives with her husband. She lives in a nursing home with her husband in Getafe, Madrid. She has been slightly depressed since she and her husband moved to the nursing home. She has lost some sight during the last years, and she does not know her way around the new neighbourhood or the venues and activities there.
12	**Jose** is an 80-year-old man who lives alone. He lives in a small, old flat in Getafe, Madrid. José was quite active before the fracture, and enjoyed going in the morning to a bar near his house with his friends.
13	**Ana** is a 76-year-old woman who has some blood pressure problems. She lives in a nursing home and needs a crutch to walk.
14	**David** has recovered from a fracture and currently he is able to walk assisted by a normal walker.

After participants watched the scenarios, they were invited to offer their initial thoughts and then were asked a series of questions drawn from the IBM framework, which sought to identify barriers and motivators to engaging with the system. These questions are contained in Appendix 1.

Procedure

Participants were recruited via email or telephone and arranged a time to attend a session at PaCT Lab in Northumbria University. Upon arrival, participants were given a description of what the study would entail and completed consent forms to indicate their willingness to take part. Participants were then given tea/coffee and biscuits to provide an informal atmosphere for discussing the system. Audio recordings were made of the subsequent interview.

At this stage, a description of the system was given to participants and they were told that our goal was to understand whether they or other friends or relatives would be interested in the system. Rather than presenting all scenarios to them, participants were told that 3-4 animations would be shown to them based on whether they were similar to themselves or a friend or relative. Participants were presented with cards that explain the persons described in the scenarios (e.g. “David has recovered from a fracture and currently is able to walk assisted by a walker.”). The persons described ranged from very active to inactive. They were asked to choose 3-4 persons that were most similar to themselves or someone that they knew well. By selecting persons similar to themselves or similar to others they know, they are best placed to answer questions on the motivations of those persons to use the system or their anticipated experiences in using it. Participants then watched an animation of each scenario connected to their chosen persons. After watching the scenario, the interviewer asked the participant about the problems and opportunities the potential user faces and reasons why the user may/may not use the system. An image of the interview location is given in Figure 3.

After the different scenarios were discussed, participants were asked to describe how they might see themselves using the system.

Figure 3: Setup for displaying animations to participants

2.2 Analytic approach

After the interviews were recorded and transcribed, the data was analysed with a framework analysis (a form of deductive thematic analysis) (Ritchie & Spencer, 1994). The codes were derived from the IBM framework and were as follows:

1. Experiential attitude – the feelings and emotions associated with the behaviour
2. Instrumental attitude – the beliefs and expectations associated with the behaviour
3. Injunctive norms – the influence of other people through their expectations of you
4. Descriptive norms – the influence of other people through what they are doing
5. Perceived control – the perception of being able to influence the behaviour
6. Self-efficacy – the perception of being able to personally accomplish the behaviour

We also included other barriers from the IBM model such as environmental constraints and habits to cover all potential barriers and motivators. The interviews were coded in both Italy and the UK

and afterwards were combined into one document[2]. The double-coding ensured agreement on coding and any disagreements were resolved through discussion. Generally, however, there were no disagreements and the coding by two groups of researchers simply ensured that the data was complete and that nothing had been missed.

These barriers and motivators were identified in order to understand how to better refine the system requirements. In the analysis which follows, each scenario is dealt with separately and relevant barriers and motivators to the scenario taking place in real-life are discussed. Suggestions are then made as to how barriers can be overcome (where possible) and motivators capitalised on. These are then translated into requirements, a full list of which is provided in Appendix 3.

[2] Appendix 2 contains the tables of coding from the work in Italy and in the UK.

2.3 Results

For the sake of clarity, this analysis will proceed on a case-by-case basis moving through each scenario in turn and listing the participants' salient objections or endorsements of the scenario. The primary focus will inevitably be on barriers because these are necessary to overcome in order for the scenario to be true to real life. Scenario numbering follows that of Deliverable 1.6 to ensure consistency. For a full list of each participant, scenario and barriers and motivators, the full tables of analysis are provided in Appendix 2. Relevant barriers, motivators and suggestions are linked to requirements which, again follow the numbering of Deliverable 1.6 to ensure consistency.

All of the scenarios were covered in the interviews apart from one (Ana). Because this is a rehabilitation scenario, it does not matter so much that it was not discussed by these participants because the rehabilitation scenarios were covered in more detail by the research at HUG). Table 2 below shows the number of times each scenario was selected. The relatively high numbers for Tom and George reflect the active nature of many of the participants.

Table 2: Number of times each scenario was discussed by participants

Scenario number	Name	Number of times discussed
1	Anthony	7
2	Isabel	3
3	Sarah	4
4	Tom	10
5	Michael	4
6	Dorothy	3
7	Fatima	3
8	George	9
9	Isabella	6
10	Manuel	3
11	Manuela	2
12	José	2
13	Ana	0
14	David	1

Scenario 1: Anthony

Demographics	Anthony is a 75-year-old man who lives alone.
Location	He lives in sheltered housing near Gateshead town centre.
Lifestyle	He lives a quiet life and doesn't get out much. Two or three times a week he walks to the local superstore to buy groceries.
Gap for activity	Anthony used to work as a miner and would meet with his friends every week for a meal. Many of his friends have since passed away or no longer live in the area.
Desire for activity	He wishes he could meet up with friends to spend time together.
Arrival of system	One day he receives a FriTab from the manager of his sheltered housing community. After spending five minutes telling the system about his interests, background, and some people that he knows, the system now begins to link him with other people who have similar interests and backgrounds.
Recommendation	The next day, the system recommends that Anthony meet up with a man named John who, according to the FriTab, used to work in the coal mining industry.
Basis for recommendation	The FriTab thinks that because both men worked in the mining industry, they might enjoy talking to each other about their mining days.
Decision	Anthony thinks this is a good idea and presses "Yes" to agree to meet John.
Implementation	The system then suggests that John and Anthony meet the next day at a local café for lunch around 1pm.

Result	Anthony and John meet the next day and enjoy having lunch together. They enjoy talking about mining in the North-East and their experiences. They agree to meet up again the next week.

Overall this scenario was well received and most participants were able to relate it to a friend that they had, or in one case, to themselves. For the participant who saw it as representing himself, his main motivation was to find a contact with shared interests. For those who saw it as representing others, they thought that the main reason why people would use it would be to improve their social involvement. However, there were significant barriers, as discussed below.

The system should not make too frequent contact because this would make the system become a nuisance (perceived control):

> *Respondent: I'm not sure whether it would become, should I say, more of a nuisance than a pleasure.*
>
> *Interviewer: Right. How can you imagine it would become a nuisance?*
>
> *Respondent: If the contact, I suppose, was more frequent or more demanding than I would be inclined towards.*

This leads to new **requirement 82**: *The system should not bombard users with recommendation prompts.* Related to this is the concern of two participants that too much information about potential activities would confuse/overload the users and that a few simple recommendations would be ideal to begin with. This relates to **requirement 11** which states that the system must *be persuasive in encouraging users to adopt recommendations.* The nature of that persuasion must take into account human psychology and insights such as the importance of making small initial changes to behaviour to encourage greater behaviour change.

A number of participants (n=3) mentioned the fear of technology (experiential attitude) as an obstacle and how people might be afraid of using the ACANTO system at first. The technology thus needs to be simple and easy to use for older adults. This reinforces **requirement 50**: Interaction must be very easy. One participant noted that if the system is sufficiently easy to get to grips with, this would provide a feeling of "mastery", having learned how to use it:

> *Interviewer: And how would it make people feel to use a system like this?*
>
> *Respondent: I think for a start once they'd mastered the fact that they could actually use the FriTab or tablet or whatever, that would make them chuffed to bits, because I know how I feel when I can't [do a] slight thing now, you know. But again knowing that they could make the effort, it improves you both socially, mentally and physically when you get out and about from your usual boring day-to-day routine.*

The feeling of mastery is a psychological need that is linked to subjective well-being and this suggests that using the system may, in itself, have psychological benefits for users (Tay & Diener, 2011).

Another obstacle mentioned by one participant is that her friend's poor eyesight might prevent her from using the FriTab. The participant suggested that audio instructions be provided to help her with this. This reinforces **requirement 49**: Provide a non-graphical visual interface for users with visual impairments.

One requirement highlighted by using the IBM model relates to social influences (descriptive and injunctive norms) in using the system. While participants acknowledge that their friends or family would be an influence on whether they use it, the key point to raise here is that users will need someone to introduce the system to them and explain how to use it. One participant suggested having a group session at the sheltered accommodation where people are introduced to the system. Another stressed the importance of receiving tuition in how to use it. While this then, is a very high-level requirement, it must be stated that *the system should be introduced to and explained to users by someone to encourage use and maximize confidence (*new **requirement 83**).

The biggest objection to this scenario came from one participant who incisively pointed out that in the scenario, the pairing of Anthony with John was made on the basis of them both having worked in mining. The participant noted that miners already have existing social structures in the form of working men's clubs:

> *Participant: Think about it. (Laughter) No that kind of thing doesn't work. If you had a pit you would have a working man's club.*
>
> *Interviewer: Yes, yes.*
>
> *Participant: They would go to the working man's club. If you are a member of the working man's club after 65 it is free and they have trips for you and stuff like that and they have […] all sorts of things. So there is already a community there. So you wouldn't do it for that. That is a wrong example. For a mining community they would look at you as if you were daft if you took that in, because it's not the right example to use.*

The use of a system like this to link miners to other miners would thus be redundant. While our initial idea was to link people together based on similarities such as occupational background, it seems best to allow users to choose the attributes on which they wish to receive pairing recommendations. For those users who feel that their work background is irrelevant to pairings, they should be able to select others attributes on which they may wish to be paired (e.g. shared interests). This leads to refinement of **requirement 29** (Link users with similar interests): *The system should link users with similar interests that they wish to be matched on.*

Despite these concerns, the scenario was well-received and one participant was particularly enthusiastic about the potential for himself:

> *It would provide an opportunity of improving my social life, which would be triggering off some aim in life, whereas at the moment it's rather closing in on me rather than spreading out.*

The idea that the system could provide "some aim in life" is rich in significance and points to the value of such a system if well-implemented.

Scenario 2: Isabel

Demographics	Isabel is an 82-year-old woman who has lived alone for the past two years
Location	She lives in a flat by herself in Newcastle.
Lifestyle	She no longer goes out very often and has become very physically inactive. Her daughter brings her groceries once a week.
Gap for activity	While Isabel used to enjoy going for walks in the local park, she no longer has anyone to go walking with.
Desire for activity	She recalls the times she spent walking with fondness and wishes that she had someone to go walking with.
Arrival of system	One day, she receives an invitation by mail to try out the new FriTab and FriWalk system. After receiving the system when a researcher visits her, she tells the system about her background and interests. She tells the system that she used to enjoy walking.
Recommendation	Later that day, the FriTab suggests that she meet a lady in the next street, Martha, who likes to visit the local shopping mall and has similar mobility problems.
Basis for recommendation	The system has noticed that Isabel does not have many friends and believes that if she had a friend who also enjoyed going for walks, she might go there again.
Decision	Isabel is hesitant at first but then agrees to meet up and try out the FriWalk.
Implementation	The FriTab tells Isabel to meet Martha the following Wednesday at 10am to enjoy a morning together at the shopping mall
Using FriWalk features	Once she arrives to the shopping mall, the FriWalk shows the directions to get in touch with Martha at the prescribed time. Since Martha has a similar FriWalk, the two ladies meet with any problem. Isabel and Martha go for a walk in the mall and decide to buy some groceries. The FriWalk suggests the route and monitor the execution of the activity, which is based on medical prescriptions. The FriWalk sets a comfortable pace for them to walk at. During the walk, the FriTab realises that Martha feels a little bit tired and suggests to interrupt with

	the planned activity. The FriTab suggests Isabel and Martha to have lunch in a local cafe.
Result	The FriWalk devices guides them to it where they have a pleasant lunch and agree to meet up again.

The three people who discussed this scenario did so with reference to a friend. Typically, these friends had mobility problems or were very inactive. While the participants felt that the system would be useful at helping these friends get out of their homes and to become more active, several reservations were mentioned. Consequently, at least two of the participants felt that their friends might not use the system.

The first reason for why someone might not use the system relates to lack of personal motivation:

> *"Respondent: You've got the fact that when you're older change is more difficult, meeting new people is very different when you're old."*

> *"Interviewer: If your friend was going to have used a system like this would you think she would have if we made some of those modifications?*
>
> *Respondent: In her 70s I would have said so. I don't think in her 80s, I don't know if she will have. I know when she left her post, [to] her sister on this dermatology ward, she said, "Jennifer, I'm just happy to keep things going now. I don't really want to… I'm not looking to improve things." That was when she was 68, because we lived in the same house for two years. […] You lose the will a bit don't you sometimes when you're older. So on the ball running the Elders' Council in Newcastle at that age and you're thinking how do you do it. Some people just don't – this one, that you asked me about, she possibly would have given it a go if she had encouragement. If people had shown her how to use it and gone with her several times, not just once, several times, I think she probably would. Certainly in her 70s she would have done, possibly in her 80s."*

The participant said that when people reach a certain age (psychologically, not physically), they can lack the motivation to change; they are content to "keep things going" rather than improving. How to overcome this is obviously a challenge. One solution is to target people before they reach that stage. Potentially, however, there may be ways of persuading such people to take part in using the system but this needs further exploration in line with **requirement 11** (persuasive design).

Another obstacle is one that has already been discussed. One participant said his stepmother might not get over the "technology hurdle":

> *"I'm not sure that they would overcome the technology hurdle. They had an entry system into the assisted living. You had to call the flat, and then she had to buzz you in through the front door. Then you got a second door, and you had to buzz again. My stepmother never quite comprehended that she had to actually buzz you in twice. Her success rate of buzzing you in was less than 50%. (Laughter) Most of the time… It was supposed to be a security system. Most of the time somebody else would let us in, and they didn't know who we were. So I'm not sure that they would be able to overcome the initial technology thing. I don't know if there's an upper age limit at which you would say, "You don't get this." My 90-year-old friend, who was extremely technology – honestly, he was one of the best systems analysts I ever met. Now he's absolutely frightened of the new technology."*

By recounting an example of how his stepmother could not come to terms with the security system in her flat, he sought to show how older adults may reach a stage when they cannot interact effectively with technology. Similarly, by pointing out his friend who used to be a systems analyst but who now cannot use the new technology, he aims to show how complicated technology can be for older adults. Granted that there are difficulties for older adults using technology by virtue of their age, from our perspective we are inclined to agree with Norman (2013)

> *"The idea that a person is at fault when something goes wrong is deeply entrenched in society. That's why we blame others and even ourselves. Unfortunately, the idea that a person is at fault is imbedded in the legal system. When major accidents occur, official*

> *courts of inquiry are set up to assess the blame. More and more often the blame is attributed to "human error." The person involved can be fined, punished, or fired. Maybe training procedures are revised. The law rests comfortably. But in my experience, human error usually is a result of poor design: it should be called system error. Humans err continually; it is an intrinsic part of our nature. System design should take this into account. Pinning the blame on the person may be a comfortable way to proceed, but why was the system ever designed so that a single act by a single person could cause calamity? Worse, blaming the person without fixing the root, underlying cause does not fix the problem: the same error is likely to be repeated by someone else." (The design of everyday things, p. 66)*

From this perspective, the difficulty of designing usable systems for older adults should be seen as a challenge to be faced, not ignored. Rather than resigning ourselves to believing that older adults cannot use technology, we should make it as user-friendly as possible in order to help them use it. This is in line with **requirement 50**, that the system should be very easy to use.

Participants also had other concerns relating to control of the system (*perceived control*). Because the users are at the mercy of the system to pick suitable companions to share activities, there was a concern that the system might pair people inadequately:

> *"There's a danger of the system saying, "Well, this person and this person will be compatible." The compatibility is not just data related. It's attitude and…"*
>
> *"Well I think if she didn't get on with someone who she met up with I think that might put her off a little bit. If they weren't very compatible I don't think that would help"*

There was a concern that the user should meet with "compatible" people in order to make the system successful. There is a risk that users could stop using the system if it paired them up with someone inadequately. But how can this be resolved? Participants did not offer many solutions but one suggested that users meet as a group first, and then decide who they like as friends:

> *I don't know how you overcome that. Perhaps do it on a group basis and then pair off. Rather than doing it point to point, if you like, which is always going to be, "Well, what's this other person going to be like?" call together a grouping, and allow them to pick the people that they would relate to.*

Because this is only a potential suggestion made by the participant and not a demand, we have not made this suggestion into a requirement. Nevertheless, there is a clear requirement that needs to be stated: *the system should seek to avoid incompatible pairing of people* (**new requirement 84**)[3]. Perhaps, however, requirement 20 may be a solution to this problem ("the system can be used as a means of safe introduction before meeting new people face to face"). Indeed, one participant suggested that this may be advantageous:

> *I would say they needed someone to introduce them rather than just have them going blind and they may have talked on the phone, that's more likely and not a mobile either. That would be more likely, somebody introduce them rather than just meeting blind. It's a bit like dating thing, isn't it? It's okay, I mean I don't mind that as a way of meeting people but when you're older you're just a bit more chary. She still has to get out on her own to meet this person.*

If the system allows people to communicate (perhaps talk) to another person before meeting face to face, then this allays some of the concerns about inappropriate matching of people when meeting up. Perhaps the system can suggest a recommendation and the user can then validate this recommendation by viewing the person's profile on the SNS, talking to them via an audio or video link, and only then agreeing to meet them in person. Perhaps even, as the participant above suggested, recommendations can be made by mutual acquaintances also.

Another barrier to use of the system related to perceived control. This was mentioned in several other scenarios also; namely, the problem of the system breaking down or failing:

> *And things that make it hard, that would stop her, stand in her way from using it?*

[3] Subsequently revised after discussion with developers – see Appendix 3 for details.

> *Well like you say, if it went dead, that would be it. And there's nobody there to tell her how to get it back on sort of thing.*

Several participants explained (in other scenarios) that if the system stopped working while in use, this would discourage the user from continuing to use it – especially if they did not then know what to do. This points to a need for sufficient error-handling capabilities of the system: the system should be able to simply explain errors to the user and notify someone who can fix the problem (**new requirement 85**). While this may not completely solve the problem of system failures, it should hopefully alleviate the stress that they can cause.

Aside from other comments about how the system would encourage people to get out of the house (which participants thought it could do), one participant was very enthusiastic about the experience that using this system could bring:

> *She probably would have been okay. I know that some people might initially feel a bit embarrassed that they look like they had a tripod walker but if people all sort of look and they say, "This is my satnav," then you think, "Oh it's street cred, satnav, how does that work?" This is what you do with it and it makes you feel worthy because you're actually telling somebody who's probably a lot younger than you how this works. So that's a street cred thing.*

The problem with many assisted-walkers for older adults is that they have been very stigmatizing (e.g. Parette & Scherer, 2004; Resnik, Allen, Isenstadt, Wasserman, & Iezzoni, 2009; Zwijsen, Niemeijer, & Hertogh, 2011). Often older adults avoid using a walker or similar assistive devices because of the fear that they will be labelled as old or disabled. While other participants were not immune to this fear of stigma from the FriWalk, it is worth noting how positive many participants felt about it. In this case, by re-framing it in terms of being a "satnav", an enabling device that provides capabilities that others might not have, the participant is able to see it as something that "makes you feel worthy." This provides the basis for **new requirement 86**: *The system should be as non-stigmatising as possible.* This will ensure maximal wellbeing of users.

Scenario 3: Sarah

Demographics	Sarah is a 72-year-old woman who lives with her husband.
Location	She lives in a small house in Corbridge.
Lifestyle	Sarah enjoys living in the rural community and has a small number of friends who live nearby.
Gap for activity	While rural life is enjoyable, she misses the days when she lived in the city and there was more to do.
Desire for activity	She wishes that she could get involved in more activities in Newcastle.
Arrival of system	One day, Sarah receives an invitation by email to try out the FriTab system. Someone visits her and helps her to set up the system. She tells the system about her local friends and that she would like to take part in more activities.
Recommendation	Shortly after entering the information, the FriTab tells her that the U3A is holding a meeting in Newcastle on Friday. It invites her to attend and tells her that her friend, Joan, who lives nearby is also going to attend.
Basis for recommendation	The system believes that U3A would be an ideal place for Sarah to get involved in various activities.
Decision	Sarah has never heard of the U3A before and asks her friend who tells her about it. She thinks it is a good idea.
Implementation	The FriTab tells her that the U3A meets on Friday at 11am so she would need to get the 9:57 service from the train station to get there on time. It tells her that she should leave the house at 9:35 to get there on time.
Result	Sarah and Joan meet at the train station on Friday and travel to the U3A where they enjoy listening to a lecture and learning about the various subgroups that they can join. They sign up for another group and look forward to visiting again.

Four participants discussed the scenario with Sarah and provided feedback. All of them answered on behalf of friends or relatives. In terms of instrumental attitude, all participants spoke about being able to have a more active social life – which is a key goal of our system. This endorses

requirement 19: Provides a means to maintain communication with existing friends and family and generate new friendships based on location and/or common interests.

When asked about how the system would make them feel as they used it, some participants spoke of positive feelings, while others expressed some barriers. Positively, the system would make people feel that "they aren't alone":

> *Interviewer: How do you think it would make them feel using the system like this?*
>
> *Respondent: It would make them feel as though they weren't alone in the world. I mean he doesn't sort of say it in those terms but you can feel where's the world gone, you know, we're stuck out here. Obviously they know their next door neighbour either side but that's about it because nobody ever goes out anywhere.*

This would satisfy the above requirement (19) that the system should make people feel more socially involved.

With regards to negative experiences, participants noted that fear of falling might prevent some people from going out. However, this scenario does not mention the FriWalk and this (the FriWalk) is the proposed solution to the problem of fear of falling. This is now stated formally in **requirement 87**: The FriWalk system should reduce fear of falling for users.

Another barrier mentioned was the feeling of being "past it" (experiential attitude). One participant said that some of his friends might say that they were past the stage of trying to get more socially involved through the technology. Clearly, feelings of resignation would be difficult to change and the system may not be able to change this.

Another participant said that unless the recommended activities were of great interest to the user, they wouldn't keep using the system (experiential attitude). On a related note, another participant said that good first experiences were important in order to keep using the system. And this is one of our goals, to provide interesting activities for the users, and consequently we have requirements to ensure this: **Requirements 5 and 30** identify the need to gather information about interests and background from the users at the commencement of using the system as well as recommending previously enjoyed activities. **Requirements 7 and 37** also state the need for the system to learn preferences through a user's history of rejecting and accepting recommendations and through their satisfaction with recommended activities. While inevitably the user might attend an activity that they do not enjoy, the system should learn from these negative experiences to ensure that the user receives more favourable activities (**Requirement 47**).

In terms of perceived control over the use of the system, one participant said that local recommendations were important:

> *Interviewer: What sort of things might help them to use the system?*
>
> *Respondent: Probably get them with other people in that area so they can come into town together rather than coming to town to meet somebody.*

Getting to know people in the local area was seen as important and this is one the requirements of our system: Provide geographically localised recommendations (**Requirement 8**).

One requirement not mentioned in our current list needs to be added: the system should take the weather into consideration when making recommendations (**new requirement 88**). This was mentioned as a potentially hindering factor when using the system:

> *Interviewer: Anything you think that would make it harder for them to use the system?*
>
> *Respondent: The weather.*
>
> *Interviewer: I take it they don't venture out much in bad weather?*
>
> *Respondent: No. He's petrified he'll fall.*
>
> *Interviewer: Obviously then the season is going to affect them as well.*
>
> *Respondent: Yes.*

In bad weather, some users may be afraid of going out. The recommendation system can quite easily check current weather and forecasted weather before recommending activities that would involve travelling through the bad weather.

Another potential barrier that arose was the remark of a participant that his friend would like to take her husband along with her when she was going out for activities:

Respondent: I don't know if that would be of any use because it's only involved in Sarah, it says nothing about her husband accompanying her.

Interviewer: Clearly he could.

Respondent: He could but it's sort of putting her in touch with another lady to go to a specific meeting. I don't know what a U3A is but in the main husbands and wives normally go out together to meetings. I mean I come to tell when someone's for retired members of union and they're all husbands and wives that go there and have a Christmas party every year and things like that. They wouldn't dream of going out without their husbands or their husbands wouldn't dream of going out without their wives.

While the person states the case rather strongly, there are some cases where probably husbands and wives would want to attend events separately. The same participant was asked later about whether he brought his wife to an event he regularly attended:

Interviewer: Do people bring their wives to the mess meetings?

Respondent: No, they don't.

His answer reveals that not all events are appropriate for both husbands and wives. However, it does suggest a requirement that the system should take into account the marital (or relationship) status of users when offering recommendations (**new requirement 89**).

Scenario 4: Tom

Demographics	Tom is a 68-year-old man who lives with his wife.
Location	Tom lives in Byker, Newcastle.
Lifestyle	Tom has quite an active social life and enjoys meeting new people.
Gap for activity	He is a volunteer in the Hancock Museum and often invites friends to see the exhibits.
Desire for activity	He often wonders how he can find other people who would be interested in visiting the museum.
Arrival of system	One day, Tom volunteers to try out the FriTab system. He is shown how to use it and he enters his background information and interests. He also selects that he coordinates some events at the museum.
Recommendation	The system then shows Tom a list of local people who are interested in natural history. It suggests that he invite them to the museum. He sends them all a message inviting them to come and visit the museum.
Basis for recommendation	The system chooses the people because they expressed an interest in natural history and believes that they would enjoy seeing the exhibits in the museum.
Decision	Three people reply to Tom and say they would like to visit the museum for a tour.
Implementation	Tom suggests that they meet the following week on Thursday at 10am for a tour.
Result	The following week, the group meets Tom and they enjoy a guided tour of the natural history exhibits.

This was the most popular scenario to discuss – probably because Tom is described as an active person who enjoys meeting new people. Most of our participants answered this question with reference to themselves and thus saw themselves as being active and sociable. The idea of the scenario was validated in many of the responses. Participants discussed how they were involved in volunteering at various organisations and believed that this system would enable them to find people to come along and either help at or benefit from their volunteering efforts (instrumental attitude). These organisations included the Gateshead Older People's Assembly (which offers pay-what-you-want lunches), the University of the Third Age (U3A, which offers activities and lectures for a nominal fee), and local charity shops. Participants were generally very enthusiastic about this scenario and had few criticisms.

Numerous barriers and motivators were discussed for this scenario. Firstly, there was the category of experiential attitudes. Positively, many participants talked about how the system would make them feel satisfied, in control of things, worthwhile at being part of a group, they would enjoy meeting new people, it would give them confidence, and make them feel empowered. Participants

were not prompted to say such things and the idea of the system clearly appeals to them. On the other hand, there were some barriers. People spoke about fear of technology, the problem of negative first experiences, and the initial nervousness at using it. The solutions to these have been addressed above (both ease of use and ensuring that recommendations fit with user interests). Naturally, these obstacles cannot be completely overcome (e.g. a fool proof method for ensuring good experiences during a recommended activity) but they can be minimized through ensuring that the recommendation system uses the interests recorded by users.

Regarding perceived control over the system, participants mentioned that users would need to be retired to find the time to adopt the recommendations, users would need to have internet access at home, the system would need to be regularly updated to ensure accurate information, and the cost of recommendations would need to be clear. Regarding internet access, this forms **requirement number 90** (the system will need to be linked to the internet to provide recommendations). In relation to the cost of recommendations, one participant was doubtful that the local museum was free while another was certain that it was. There is thus a need to be clear to users what cost, if any, adopting the recommendation will involve (**new requirement 91**).

Finally, some suggestions given by participants include that there should be an age limit on the system so that people of similar ages can meet:

> *I would have thought that possibly an age limit may be useful, but not necessarily because I guess with a thing like that scenario I guess it's the subject rather than the people, I guess […] Maybe if you're trying to get people interested, I'm just thinking of a similar sort of age, it may be of benefit, but that's the only thing I was thinking about but for this subject it probably wouldn't matter but there may be other things where you possibly wouldn't want to be meeting with a 20 year old versus an older person. For various reasons.*

This clashes with **requirement 26** which states that both younger and older people should use the system so that there can be intergenerational contact. Some users mentioned that they engage in intergenerational contact so it may be premature to shut down this possibility:

> *Interviewer: And so what kind of gap in your life would a system like this fill in?*
>
> *Respondent: Oh, being retired I'm always looking for something to fill the days, so that would be great to fill the days. I mean, personal point of view, I'm with U3A, Age UK, I volunteer for Age UK on the IT side. I do that on a Tuesday morning and a Tuesday afternoon. And on a Wednesday afternoon I go to one of the schools and do it there with sixth form pupils as a mentor. And they in turn work with the senior citizens, so it's two-way street.*

Intergenerational contact, therefore, is appropriate in some circumstances but apparently not appropriate in other circumstances. Much hinges on the reason for the meeting between generations. We continue to accept **requirement 26** but suggest **new requirement 92** to qualify it: activity recommendations should normally involve pairing older adults but in specific circumstances may link older and younger users. These intergenerational meetings should be clearly identified as such in the recommendation message.

Another issue raised is the need for users of the system to be vetted:

> *Interviewer: Can you think about any other problems that Tom might face?*
>
> *Respondent: [I] presume that everyone that's on the system that's expressed an interest would have been vetted anyway so there wouldn't be an issue with sort of undesirables I guess coming along.*

There are security issues with people meeting up offline after having met online. In ordinary circumstances, this is something that people are warned again due to the dangers of online deception. While the implementation of this is unclear, it is a clear requirement (**new requirement 93**): the system should take into consideration the safety of users when meeting other users.

Scenario 5: Michael

Demographics	Michael is a 72-year-old man who lives alone.
Location	Michael lives in Felling, Gateshead.
Lifestyle	For the past few years, he has found mobility very difficult and he is waiting for a hip operation. Consequently, he doesn't get out much.

Gap for activity	He used to enjoy visiting museums and now fulfils his passion for natural history by watching documentaries on TV.
Desire for activity	He would like to be able to get out to visit the museums in Newcastle.
Arrival of system	Someone visits Michael one day and shows him the FriTab. Michael explains to the person that he has mobility problems so can't walk for long periods of time. But the person explains the FriWalk to him which is owned by several shops, galleries and museums in the area. So Michael enters his details into the system and tells it that he has mobility problems.
Recommendation	The next day, the FriTab shows Michael that a tour is being organised at the Hancock Museum. It invites him to attend and tells him that there are FriWalks at the museum.
Basis for recommendation	The system knows that Michael enjoys natural history and that he also has mobility problems. It knows that the museum owns FriWalk devices that could help Michael.
Decision	Michael is hesitant but agrees to give it a try. So he tells the system that he will attend.
Implementation	The FriTab tells him when the tour starts and where in the museum it will start from.
Result	When he arrives at the museum, he is given a FriWalk which helps him to walk with the rest of the tour group. After the tour is over, the FriWalk even suggests a guided tour of its own that Michael can do alone. Michael is tired but decides to come back and try the guided tour another day.

Four participants discussed this scenario; two answered with reference to a friend and two answered for themselves. One of the participants already uses a walker so was familiar with the idea of having to use one.

The instrumental attitudes that motivated anticipated use of the proposed system revolved around getting out, being more socially involved and having a device that could support the user physically and provide a place where they could rest. For that reason, the seat was mentioned by two participants as something that was very important. For the participant who already used a walker, we were interested whether he would see the benefits of switching to the FriWalk rather than continuing to use his own walker. Among the benefits he mentioned of using the FriWalk was the presence of a seat:

> *Interviewer: So you mentioned the mobility problem and I guess my question would be, "How well do you think this kind of system would solve your mobility problem?" Because obviously you've got your walker, which helps you to get around, so would there be much added value to have one of these FriWalks?*
>
> *Respondent: Yes, it's got the seat on it. Yes, it would. I mean, as I said previously, when I'm walking around events or in the square, I've got to have a seat occasionally. And a good lady will say to me, "Are you tired?" "I'm all right," you know, you just go on and take a seat. So you have a seat, you rest for a couple of minutes, five minutes and then up and away again until the next bout comes on.*

While this is a relatively basic feature, it reinforces our **requirement 66** that the FriWalk should have a seat in order to be able to support users.

Another instrumental benefit that this user mentioned was the presence of transport information:

> *Interviewer: Okay, makes sense. Any way in which you think it could be changed to better help you?*
>
> *Respondent: If it suggested some way of transportation, if the actual machine- I called it a machine- the actual unit had said, you know, "On your return journey there is such and such an option and such and such an option." That may be something advantageous.*
>
> *Interviewer: Right, okay. Just to let people know how they could get back. Okay.*
>
> *Respondent: Yes. Or, as I say, if he's interested in something further, the transport links from your area to the Discovery are such and such.*

It was interesting that the participant spontaneously discussed this without prior prompting and this supports our previous stated requirements that the system should communicate transport information to users **(requirements 15 and 42).**

Generally, when participants talked about experiential attitudes to the system, they were positive and referred to feelings of self-confidence and liberation (being able to walk where you want without worrying about where to find a seat or getting tired). One participant was more negative and pointed out that her friend probably wouldn't use the system at the moment because his hip is too painful to allow much walking (he is waiting for a hip operation). This suggests that our scenario may be slightly optimistic. The participant explained that in the earlier stages of waiting for the hip operation, her friend may have used the FriWalk, so this provides some basis for believing that in the earlier stages of waiting for hip surgery, the FriWalk system may be ideal.

In terms of influential people who might encourage people to use the system, participants often reported the influence of family and friends. When discussing this scenario, one participant specifically identified his son-in-law who was a paramedic:

> *Interviewer: I'm just trying to figure out if I were to try and encourage you to use it, would that be sufficient encouragement or would it need your daughter to encourage you?*
>
> *Respondent: Well, they certainly encourage me. I feel particularly happy that my son-in-law is there with his knowledge as a paramedic. They did take me to see the Flying Scot when it was on the North Yorkshire Railway. I got there to the viewpoint that they had in mind on a flat walk which was about a mile (which was before I fainted in the gym). So I managed that alright. Then they suggested I could get back by going slightly uphill over the country. So I said, "Oh, I'll have a go," and it didn't look too bad but I semi-collapsed two or three times in doing that stretch, to the extent my son-in-law said did I need an ambulance? So I said I would manage, but was glad to get back into the car when I got to the other end. So that sort of moral support I found helpful.*

Trust in particular individuals who have helped in the past (such as his son-in-law) seems to be important for potential users. This suggests that people who have assisted their wellbeing in the past will be particularly heeded if they encourage them to use the system. While this is not a system requirement, it can be seen as a more general recommendation that the system should be introduced by people who are known to the potential users, and whom they trust.

Perceived control over use of the system was an area where more obstacles to use surfaced. Firstly, one participant pointed out the problem of getting from the house to the museum. While FriWalks are located at museums, there is no solution identified in the scenario for getting the user from the house to the museum. Here, we make the assumption that the user will be able to get to the museum by some means. One of our participants, for example, already used a walker but was eager to use the FriWalk system at locations such as museums. Other users of the system might be able to walk a short distance to a bus or taxi, for example. The requirements necessary to ensure that the user can get to the location to use the FriWalk are **requirements 27** (be aware of mobility problems of users) and **31** (Transportation mode availability/preferences). More specifically, we can also suggest **new requirement 94** (the system should not recommend places for the user to go that their mobility would preclude).

Secondly, another potential obstacle is the perceived sturdiness of the system. One participant said,

> *But if he's got issues with it, wobbly wheels or whatever, issues with the machine itself, uncomfortable maybe, not right for him, you know the ergonomic side of things, it's quite possible that maybe he doesn't feel comfortable doing that, although he likes the idea of it but the technology it still makes things difficult.*

This reinforces our requirement that the perception of the FriWalk should be of sturdiness and reliability **(requirement 63).** The FriWalk needs to be designed in such a way as to inspire confidence in the users.

Finally, one participant mentioned that different people would walk at different speeds when using the FriWalk. When asked about whether people should be slowed down so that they walked together, he objected and suggested that some people would naturally slow down:

> *If you're going to make the walkers slow down, you're slowing down the user. The user might be quite happy just to trundle on at a slow pace, rather than be slowed- physically slowed down. So I wouldn't see the benefit in that at all. I think it would just be a case of- I think it would just be a case of, you know, I'm using my walker, I can't really go very*

fast. And somebody- as I say, I think human nature would be- I think folk would probably slow down.

This is relevant because **requirement 60** says that walking pace will be communicated to other users of the FriWalk. Clearly this communication of walking pace should not take place by slowing some users down. The idea of using anklets to communicate pace in order to slow people down was raised by the interviewer and the respondent said:

I think it's too dictatorial. Definitely too dictatorial. I think it's just a case of, you know, I can't walk quickly, if you're coming around with me you walk at my pace and that's it.

If walking pace is to be communicated to other people in a group, it cannot be by forcing other people to slow down. This breeds a feeling of being dictated to and may cause people to reject the system. **Requirement 60** has thus been refined to say, "Communicate walking pace to another user if permitted by user and in a non-constraining manner".

Scenario 6: Dorothy

Demographics	Dorothy is a 69-year-old woman who lives alone.
Location	She lives in Blaydon.
Lifestyle	Dorothy uses a walker to get around because she finds that it gives her confidence after her fall one year ago.
Gap for activity	Dorothy loves shopping and likes it when her friend occasionally takes her shopping at the MetroCentre.
Desire for activity	While she likes the MetroCentre, she is nervous about going there alone and worries that she would get lost. But she would like to go there more often.
Arrival of system	Dorothy is shown the FriTab and told that it clips onto FriWalk devices which are available at the MetroCentre. She decides to try out the FriTab system.
Recommendation	Several days later, the system suggests that Dorothy visit the MetroCentre to enjoy some shopping.
Basis for recommendation	The system has noticed that Dorothy has stayed indoors for several days and believes that she would benefit from getting out.
Decision	Dorothy thinks that it would be a good idea and asks the FriTab for more information.
Implementation	The FriTab suggests that she get the 2:15 bus from the nearby bus stop which will take her to the MetroCentre. It tells her that it will give her directions to the MetroCentre and will help her find her way around inside.
Result	She gets the bus and travels to the MetroCentre. When she gets there she swaps her walker for a FriWalk and clips in her FriTab. The FriTab shows her that several shops have sales and gives her directions. When she starts feeling tired, she presses a button on the FriTab and it directs her back to where her walker is. She unclips her FriTab and it tells her where to get the bus home.

Three participants discussed this scenario; two referring to themselves and one to a friend. All participants were enthusiastic about the scenario. Participants spoke about the need for such a system because of fear of falling, lack of confidence and lack of motivation. All agreed that the system would help to alleviate these problems.

In terms of instrumental attitudes, one participant "loved" the idea of the reminder from the system to go out after having been indoors for some time. This is now specified formally as **requirement 95**: The system should detect when a user is spending too long at home and should recommend an activity.

Another participant liked the idea of having directions for the shopping centre but said that she would not want it presently, because she does not need it. On the other hand, one participant said that directions would be useful because sometimes she is in need of finding a nearby toilet and sometimes the names of locations change:

Interviewer: So in terms of ways in which you could see the system being improved to help meet the problems that exist, can you see any room for improvement?

Respondent: I don't know whether I understand it completely. The only thing that comes into my mind is I've got a series kidney condition, which I think you know about. So I have to have the loo every two hours. So- and I don't think that is too difficult, but I never remember where they are. So I presume it will highlight the loos?

Interviewer: Yes. Well this is one of the things that we'd actually wanted to do. We were going to have a map of the indoor environment, where it's going to be able to tell you where the nearest toilets are. And it can also guide routes to keep you fairly close to the toilets as well.

Respondent: Right, so I could- I could actually plan. Because we just do haphazard. With the bit from the bus station, as we call it, we know. They change names of things as well. It's very frustrating. So I presume it would be updated, that would be essential. So if they change it to Travel Configuration instead of what it- from Bus Station, it would come up as Bus Station or something.

Interviewer: Yes, that's an interesting one, yes.

Respondent: Because Newcastle changes names of things. And the little pathways and shopping things have got funny- go down George's Mall and I- you know, I thought that was Northumberland Street, you know? The names are really important. Toilets are really important. Seats are really important. Drinks are really important.

This rather lengthy quotation shows the importance of an indoor navigation system for someone with health problems, and the challenges facing people in relatively unfamiliar environments. This reinforces **requirement 43** (ability to provide navigation instructions in public spaces) and the underlying **requirement 40** (be aware of user's location). An additional new requirement is also suggested by the participant's preference for having consistent naming of locations (**requirement 96**): The navigation system should display consistent naming of places over time and location.

Another instrumental attitude relates to the ability of the FriWalk to carry shopping:

Respondent: I do carry, but- oh, I presume then I could actually- I could take more stuff, couldn't I, with me? Because this has got a…

Interviewer: It's got a little basket in it, yes.

Respondent: Yes. So it's got a seat and often they have a thing underneath.

Interviewer: A basket underneath, yes.

Respondent: Yes. Because that's helpful. Because I have to carry around 24 hours, just in case I'm rushed off to hospital because I don't have my equipment. So before I shop, I've got- I'm like, almost full. So that's the other thing is making sure it's got saddlebags on it for extra shopping, that sort of thing.

This participant and others mentioned the need for the FriWalk to have a basket to enable them to carry some items. This endorses **requirement 70** (Should be able to carry some a few items of shopping for the user) and makes sense if the FriWalk is to be used in shopping environments.

More specifically dealing with shopping, one participant said that information about sales and similar shops would be useful (endorsing **requirements 3, 4 and 28**):

Interviewer: Yes. And so what if it was telling you about sales that were on in certain shops? Would that be something you would be interested in or not?

Respondent: Probably. I like a sale.

Interviewer: Or similar shops? Because there's always new shops opening up, so you might- you might be browsing through say Lakeland or something and it says, you know, "There's a similar sort of shop."

Respondent: Could be nice not just shopping, but somewhere to eat. You know, I think that might be something you wouldn't know. So if it could direct you to the kind of food you want, that would be even better than the shops. Because most shops, you know about them and if one's got a sale they nearly all have.

Interviewer: Yes, that's true.

Respondent: But somewhere more interesting to eat or to suit your particular kind of eating, that would be very useful, yes.

More interesting than the endorsement of these requirements is the suggestion that the system could tell her where she could eat at a large shopping centre based on her food preferences. This does not need new requirements but clarifies that the category of "shop" in the requirements should include restaurants.

The main barriers to use come from the perceived control category and include the need for customisable size, ease of use, and non-embarrassing signals from the FriWalk. Regarding size, one participant said that the walker needs to be height adjustable (**requirement 61**). Also regarding size, a participant said that the walker should be slim enough to avoid catching the stands in shops (**new requirement 97**). On a related note, respondents said that the walker should be easy to manoeuvre (**requirement 65**).

Finally, one participant in this scenario suggested that it would be good if the walker could be motorised to help her move around:

> *Respondent: Because sometimes I can- does it actually move itself?*
>
> *Interviewer: It can do both. It can move by itself and…*
>
> *Respondent: I think that would be really handy for me at times, just a little- but not drag me like, because I have floppy ankles, so I have to make sure I pick my feet up.*

This introduces **new requirement 98** (the walker should be able to move by itself). This ensures that users are able to use this facility to help them move around when they need a bit of help.

Scenario 7: Fatima

Demographics	Fatima is a 73-year-old lady who lives with her husband.
Location	She lives in Hexham.
Lifestyle	She is reasonably active and enjoys using her walker to help her get around.
Gap for activity	Fatima likes visiting her local shopping centre.
Desire for activity	She would like to receive notifications about sales at the shopping centre so that she can visit.
Arrival of system	Fatima is introduced to the FriWalk at the shopping centre one day.
Recommendation	After using the system for about a year, the system recommends that Fatima visits her doctor. She has not been for some time.
Basis for recommendation	The FriWalk has noticed that Fatima's gait has changed during her regular shopping trips. It has notified her doctor of this.
Decision	Fatima agrees to visit the doctor.
Implementation	She phones to book an appointment. She tells the receptionist that she wants a check-up.
Result	Fatima visits the doctor. The doctor can see that her gait has changed and administers some tests. She then recommends some exercises for her.

This scenario describes how regular use of a FriWalk can detect gait change and notify the doctor. It was helpful in eliciting discussion from three participants, all of whom referred to a friend when discussing it.

Experientially, people were positive about the system. Using it regularly would make it feel like "having a pair of gloves on" because of their familiarity due to repeated use. Furthermore, it was perceived as being much better than a wheelchair because the user would be at the same height as other people and would be able to interact more easily. On a slightly more negative note, one participant worried that his friend would be wary of using the system because people don't like other people to know what's wrong with them:

> *Interviewer: So how do you think he would feel about a system that was able to, you know, if he was using it in the shopping centre, it would be able to see how he was walking and then pass that information on to the doctor?*
>
> *Respondent: I think a lot of people would be very wary of the system to start off with because they don't like other people knowing what's wrong with them. They like to think. But in a sense, it would help some people if, if your using a walker and your improving, and you go to the doctor and the doctor says, well this walker's improving you but if you do this little bit of exercise, it might help you a bit more.*

The participant does not rule out using the system but acknowledges wariness due to the disclosure of information. Users tend to want privacy and this system would share all the information with a doctor. In many ways, this supports **requirement 25** that the system should only share information with a doctor based on the user's privacy profile. This may alleviate concerns if users have more control over their information. Nevertheless, the user acknowledges the benefit of a system that could recommend visits to the doctor and this supports **requirement 9** (Recommends visits to medical professional based on physical activity/performance decline).

Scenario 8: George

Demographics	George is an 81-year-old man who lives alone.
Location	He lives in Newcastle.
Lifestyle	George is quite active and enjoys helping others.
Gap for activity	He has a keen interest in acting and used to be a member of an acting group. He enjoys helping younger people develop their skills.
Desire for activity	He would like to be a member of an acting group but is not aware of any nearby.
Arrival of system	One day, George is introduced to the FriTab system and after entering his information, begins to use it regularly. He finds it helpful to find out about local events.
Recommendation	One day when George is checking his FriTab, it tells him that there is a new pantomime group starting at a nearby small theatre. It suggests that he goes along to meet others.
Basis for recommendation	The system knows that George likes acting and believes that he would enjoy this new group.
Decision	George agrees to go along and investigate the new group. He tells the FriTab by pressing a button to say he will attend.
Implementation	The FriTab alerts the rest of the group that he will attend. They tell him that they will meet on the following week on Friday at 1PM in the local small theatre.
Result	George attends the initial meeting and is pleased to find people from various age-groups who want to take part. He enjoys working with younger people and this gives him a good opportunity to share his skills with them. Over time, he becomes a valued member of the group.

Many participants chose to discuss the scenario of George because he was described as active and as someone who enjoyed helping others. They discussed their various interests and were positive about how the system could help them find other people with similar interests and be more socially involved.

Rather than focussing on the many positive comments that people made, it is best to focus on the obstacles to use in order to refine the requirements. In the area of experiential attitudes, one participant said that they would find it hard to go along by themselves to a group and that it would be easier if they met an individual from the group first before going along. Another solution to this problem may be identified by another participant who said that it would be better to contact people by video-link first before meeting up. This seems to be an ideal solution since several participants mentioned their wariness of meeting a new person for the first time. Using a video call facility would allow people to meet and gauge how interested they would be in meeting up offline. This validates **requirement 39** (email and video-calling should be provided) and **requirement 20** (the system is a safe way of meeting people before meeting face to face). Rather than issuing new requirements from the suggestions of these participants, it suggests that the scenario would be more appealing if the video-calling feature was implemented in the scenario.

Another barrier that someone mentioned was that they would like to know the age range of the people in the group before they went along to meet the group:

> *The other thing that put me off is that it said he went along, was pleased to find there were lots of other people of different age groups. I don't think I would have wanted to go along unless I was told in advance there were people of different age groups.*

This seems to be based on an assumption that he would be happy with going to the group as long as they were of a similar age. This endorses **requirement 92** that intergenerational contact should be clearly identified in a recommendation.

Another participant said that they would need the terminology surrounding the system to be clear:

Interviewer: And what sort of things would make it hard to use it? Difficult access?

Respondent: The language, you know. As technology has-

Interviewer: The terminology.

Respondent: -developed, it's developed its own language. And when you're outside the loop, you don't know, they might as well be talking Cantonese. When they talk to me about iPads, I don't know what they mean. I haven't got a clue what they mean. "Oh, they ___." And I think, "What does iPad mean?" I don't even know what the title means, and so I turn away from it. That's my ___. If it's difficult, forget it. I don't want the hassle.

This is an important point and while it is not formally stated as a requirement (it is not a requirement for the system), it is a requirement for the designers and developers to ensure that the system is presented in a way that minimizes confusion and uses simple language. Nevertheless, **requirement 50** has been revised to address the broader issue of simple language: Interaction must be very easy and must use clearly-worded instructions.

A final suggestion made by a participant is useful; recommendations should be adjusted for preferences of the user:

I suppose you would have in, or you could put in your profile, preferred places of meeting, and, "I don't object to alcohol", or, "I do object to alcohol. I drink coffee." Or drink tea or what have you.

More generally, this can be specified as **new requirement 99**: The system should allow users to specify activities or places that they do not want recommendations for. It is important for the system to make recommendations about specified interests, but it should also be aware of what the user is not interested in (e.g. not interested in going to pubs).

Scenario 9: Isabella

Demographics	Isabella is an 89-year-old woman who lives alone.
Location	She lives in Newcastle City Centre.
Lifestyle	She is not as active as she used to be because her eyesight is getting worse and she worries about losing her way.
Gap for activity	She used to like to go to large shopping centres to explore but feels daunted by the size of them.
Desire for activity	She would like to visit larger shopping centres without being afraid of getting lost.
Arrival of system	One day she ventures out to a large shopping centre where a member of staff encourages her to try out the new FriWalk. She doesn't have her own FriTab so she uses one that the shopping centre provides.
Recommendation	Isabella selects her favourite shop from the list of possible shops and the FriWalk provides directions for her. It also recommends several similar shops that she might like to visit.
Basis for recommendation	The system believes that she might like to visit other shops that offer similar products to the one she has selected to visit.
Decision	After visiting her favourite shop, she decides to visit a similar shop recommended by the system.
Implementation	The FriTab and FriWalk give her directions to the similar shop.
Using FriWalk features	As she follows the directions, the FriWalk is able to gently steer the wheels in the right direction. At one point, she is veering towards a crowd of young people standing in the mall. But the FriWalk sees the group and gently steers her around it.
Result	After exploring the shopping centre with the help of the FriWalk, she is impressed with the abilities of the system and thinks she will use it again. It makes getting around the large shopping centre much easier.

Six participants discussed the case of Isabella who provided the opportunity to discuss issues relating to navigation and shopping using the FriWalk. Two participants answered with reference to themselves and the other four answered for a friend. Most of the people identified as corresponding to Isabella also had eyesight problems and they considered whether the system would be useful to alleviate this problem. Problems faced due to bad eyesight included difficulty in

navigating train stations, reading labels in shops, loss of confidence in going out, difficulty finding things in shops, and difficulty seeing slides at presentations. The system is unable to address all of these problems (e.g. seeing slideshows) but will address some of them (e.g. navigating shops and improving confidence in going out).

Experiential attitudes were important and while there were positive comments about how the system might make the user feel helped, more confident, and empowered, but there were some concerns and it is to these that we turn. Firstly, one participant said that if the system steered her she might feel that she was being "nannied":

> *I think she might- she would find that a bit cloying and nannying. I think she would anyway. And I'm not sure that- it depends on your state of mind, I suppose. But I don't know whether I would want to be steered by somebody else to the shop. I would want to do that myself.*

This probably varies between users because some people appreciated the idea of being steered by the system:

> *Your friend, for example? Why would she use this system?*
>
> *Respondent: Well, if it was going to take her to where she wanted to- needed to be, yes. It would- it might cut out a lot of wrong directions and things, yes.*

Consequently, **requirement 58** has been refined to say, "Provides navigation prompts in public spaces *if desired by the user*" (addition in italics).

Similarly, regarding modes of navigation, this participant felt that audible directions from the system given in public could be embarrassing. Furthermore, she felt that haptic navigation would be better than automated steering or audible feedback:

> *Interviewer: One of the things that you mentioned was that if it was steering you, you might feel like you were being nannied a bit.*
>
> *Respondent: I would. Whether…*
>
> *Interviewer: Yes. What if it was bracelets that vibrated?*
>
> *Respondent: That's a bit more secret, isn't it?*
>
> *Interviewer: Yes. So how would it make you feel using a system like that?*
>
> *Respondent: What, with the bracelets?*
>
> *Interviewer: Yes.*
>
> *Respondent: I think I'd be tickled with that, yes.*

While participants differed between the ways in which they preferred to be guided, this supports **requirement 81** (Haptic feedback will be provided available to users if they desire).

Two participants also mentioned the stigma of using a walker. One said that it might make him look silly but that he would only affect him slightly. Another said that her friend would not want to use the walker because it would make her appear as if she had problems:

> *Interviewer: And the friend who wouldn't have used it, why do you think that she wouldn't have used it?*
>
> *Respondent: Because I think she'd rather people didn't know she had particular problems, because she doesn't like - she feels it's a sign of weakness to let people know.*
>
> *Interviewer: Which is interesting because of course obviously a lot of blind or partially-sighted people like to make sure people do know, because it makes people get out of the way, it makes people-*
>
> *Respondent: I know, but she felt she was letting herself down.*

While this is a clear obstacle, there is very little that can be done beyond what is already being done to address the problem of stigma. Individuals vary on their attitudes to the use of assistive technology and for some people, using any assistive technology may feel like they are "letting themselves down".

On a more positive note, one participant said that using the system would feel like having a friend:

> *And I think- it's like custom- if I had one of my own and I could- it was customised to me, that's really nice. It's like a friend. I am on my own, my family don't have contact, relatives*

> *don't. I've had two friends leave me earlier this year. I am getting out and making acquaintances. I take a long time, so this would, like, fill that gap. It sounds weird talking like this, that a piece of equipment could do this. And I think that's the fantastic idea. I would talk to it and the fact that it wouldn't answer back might be awkward. But I could put the answers in, because I would like to say thank you to it. You know, I can't believe I'm talking like this, but it would really be great. And then I think I might use it when I'm not as bad, because it would provide all those things for me.*

While not having any direct relation to the requirements of the system, it confirms our desire that the system should be an assistive "friend" – hence the terms *Fri*Walk and *Fri*Tab. Experientially, the system should be able to encourage, inspire confidence and empower users to be more physically and socially active.

In terms of instrumental attitudes, participants appreciated the ability of the system to avoid obstacles:

> *But I like the idea of walking around, because that is- the biggest thing is being confronted with a crowd of people. You can hear, so I can hear all this going off. I can- at my worst, I don't see features. So you know, I could smell perfume and aftershave and that sort of thing. This gives you space, so if it's beeping, if it's moving you or if it just naturally goes around the way, I think that's lovely. I've not long been to the Metro Centre and it would have been lovely.*

The participant describes the experience of being at a large shopping centre and said that it would have been "lovely" if it had been able to help her avoid crowds of people. This supports **requirements 57 and 59** that the system should avoid collisions with obstacles and people.

Perceived control was another influential factor influencing use of the system. One participant was disappointed that the system couldn't tell her when to cross the road if she was using it outdoors. However, for various reasons (technical and safety reasons), this is not going to be stated as a requirement of the system. Pedestrian crossings (in the UK at least) are already fitted with components to give feedback to blind or partially sighted users so implementing this in the system would be redundant.

Another participant emphasized the importance of ergonomics:

> *I do- I have numbness in my hands. But I do a grip. I presume- how would the grip bit- would it be- could you choose your grip bit? Sometimes I can do like, a handlebar, but other times I'm- oh, […] I've got with a thingy grip. It's- yes, that, like that.*

The numbness in the hands has special relevance to braking since most walkers require the user to brake by pulling on levers located below each handgrip. This supports **requirement 62** which states that the walker should not require tight grip. Older adults sometimes have problems with their hands and ensuring that it is easy for them to hold the walker and apply the brakes is essential.

On a related note, the participant wondered what would happen if she froze and wasn't able to move further:

> *Interviewer: Yes, yes. Okay, so you're trying to wonder would it stop if you seized?*
>
> *Respondent: Yes. Because if I became detached from it, that would be really awkward. Are you connected in- because I go on- I'm just going… What do you call those machines in the gym? Like a walker, but it's not a walker. Stepper.*
>
> *Interviewer: Treadmill?*
>
> *Respondent: Treadmill, that's it. You have a thing attached to you.*
>
> *Interviewer: A cord attached to it.*
>
> *Respondent: Yes and a little alarm goes when you become detached. That's an idea, because that would be my worst- sorry, I possibly didn't say it in the question that you asked me. But like you said, you come around to things. If I became- I possibly would panic. I don't want to go back to panic. I do a bit of anxiety, that's okay. That's about where I am. I'd want it to stay with me and then let me knew where to sit, because at that time I would need to sit to recover. I recover much better from the anxiety thing sitting. Am I- this is making sense, isn't it?*

This is an important observation, because if the walker is semi-autonomous, it needs to stop when it becomes separated from the user. While the participant suggests a kind of emergency cord which would stop the walker if she became detached, it is sufficient at this stage to state the requirement more generally: The FriWalk should stop if the user becomes detached from it (**new requirement 100**).

Scenario 10: Manuel

Demographics	Manuel is a 74-year-old man who lives alone.
Location	He lives in an apartment in Madrid.
Lifestyle	He recently suffered a bad fall which has made it difficult for him to get around. He is undergoing therapy at a local falls clinic and is slowly getting better. At the clinic he is given a FriWalk to help him move around and to give him exercises to perform at home.
Gap for activity	Back at home, Manuel is now afraid to go out. He worries that he might fall with no one to help him.
Desire for activity	He would like to go back to his local museum because he has not been there since his fall.
Recommendation	One day, the FriTab on his FriWalk says that he should go to the local museum. It tells him that his friend, Francisco, who also has a FriTab, is going to the museum and they could go together.
Basis for recommendation	Every day, the FriWalk has asked Manuel to do exercises to help improve his balance. It has noticed that his balance has improved. It thinks he will be able to go out without the help of his FriWalk.
Decision	Manuel agrees to go to the museum. He feels reassured by the help of his friend.
Implementation	The next day, Francisco visits Manuel's house and they walk to the museum together.
Result	They both enjoy their visit to the museum. Because Manuel can see where his friends are going on his FriTab, he decides he will try to go out with them more often.

This and the following scenarios are focused on use of the walker for rehabilitation. While we were using non-clinical participants for these discussions, the more clinically focused discussions were carried on at HUG and are discussed later in this report.

Three participants discussed this scenario, one of whom talked about herself and two talking about friends or family. None of the participants seemed keen on using the FriWalk, citing concerns about the stigma of walking aids and independence. Despite this, participants said they would use it if they needed it. Because this is a rehabilitation scenario, this is ultimately our key concern – that people who need it use it.

Regarding experiential attitudes, one participant said that she liked the idea of the system prodding her to do exercises:

> *Respondent: I like the balance idea. I know the balance exercises. Prodding, it might prod you, "Alright, do it." Prodding does help.*
>
> *Interviewer: Yes. That's the idea, that we'll be able to encourage people to do the exercises.*
>
> *Respondent: Prodding to do it. We all know we should do it, but it helps.*

Our idea of the system is that it will encourage the user to do exercises when they are outside of the direct supervision of hospital staff. The participant notes that this would encourage her to do exercises and likes the idea. This supports **requirements 67 and 78** in which the system recommends exercises to users.

In terms of instrumental attitudes, participants agreed that they would use it if they had to. One participant said that he had a friend who would use it because it could give information about improvement or decline:

> *The attraction would have been the capability of the machine, telling her, advising her or somebody, improvement or not improvement. I think that's the attraction of it.*

This lends support to **requirement 46**, that the system provide feedback to participants on their progress towards physical activity targets.

Another participant mentioned that she wouldn't find the FriWalk as useful if she couldn't have it at home:

Respondent: In just the public place, it's not so valuable. I think I would rather have it in retail so that I could buy it, or if they get them on National Health or something. You need it all the time, because like I say, I have to walk to my shops, which are a good 10 minutes or something like that.

Interviewer: Okay. That makes sense. It definitely makes sense. So you would need to have it all the time if it was going to be useful?

Respondent: I think I'd need to have it in the house, yes.

While there is some discussion over whether this device would be available only at clinics or care facilities, this participant clearly expresses a desire to have it at home to enable her to get to her shops.

Scenario 11: Manuela

Demographics	Manuela is an 83-year-old woman who lives with her husband
Location	She lives in a nursing home with her husband in Getafe, Madrid
Lifestyle	She has been slightly depressed since she and her husband moved to the nursing home. She has lost some sight during the last years, and she does not know her way around the new neighbourhood or the venues and activities there.
Gap for activity	She is unmotivated, she does not know the surroundings of the nursing home where she is living and does not feel confident enough to go outside the nursing home without her husband.
Desire for activity	She would like to feel more confident to perform activities on her own, and to regain some independence.
Arrival of system	After Manuela has suffered a fall, she has a visit with Dr. Sánchez, her geriatrician. Dr. Sánchez knows that Manuela lives in a nursing home that has some FriWalks. Dr. Sánchez sets up an exercise plan for Manuela that she can do at the nursing home.
Using FriWalk features	Some mornings, while her husband is out with their friends, Manuela goes to the gym in the nursing home. The nursing home counts on 2 FriWalks that are shared among all residents subscribed to an exercise program. When one of the FriWalk gets available, Manuela takes it and “logs in”. The FriWalk guides her through her exercise program. Once she finishes, the FriWalk asks her how she has been.
Recommendation	After performing an exercise session at the nursing home, the FriTab in the FriWalk tells Manuela that a group of people from the nursing home will be attending a watercolour expo near the nursing home, in a venue she did not know.
Basis for recommendation	Manuela has regained a good functional status, and she should start doing activities on her own.
Decision	She feels more confident about her walking capacities, so she agrees to go to the watercolour expo.

Two people discussed this scenario. One referred to herself because she had macular degeneration and the other referred to a friend living in sheltered accommodation. Neither referred specifically to the rehabilitation use of the walker so there is little to say on this scenario regarding requirements refinement. This scenario is discussed further in the interviews at HUG.

Scenario 12: Jose

Demographics	Jose is an 80-year-old man who lives alone
Location	He lives in a small, old flat in Getafe, Madrid
Lifestyle	José was quite active before the fracture, and enjoyed going in the morning to a bar near his house with his friends.
Gap for activity	José is feeling some pain when he walks, and he does not know how much exercise would be good for him.
Desire for activity	José has the idea that everyone he knows that has suffered a hip fracture has died in the following year, and he is scared it might happen to him.
Arrival of system	José starts using the FriWalk in order to stand up and walk through the hospital alleys. When he is discharged, the geriatrician recommends José

	with a Day Centre near his house where they have some FriWalks, as José lives far from the Hospital and it would take him too long to follow the exercise program at the Day Hospital. The geriatrician then sets an exercise program for José.
Using FriWalk features	José goes to the Day Centre three times per week early in the morning. There, he uses the FriWalk to perform the recommended exercise program. He can also notify Dr Sánchez whether he feels pain or not, and how tired he has felt after the exercise.
Basis for recommendation	It is extremely important to regain a good level of functional capacity after a hip fracture in order to avoid disability and even death. Factors that might hinder the performance of exercise include pain or fear or falling, so the FriWalk can help to relieve these.

Two participants discussed this scenario, one of whom had had a hip replacement. In terms of experiential attitude, one participant said that it was kind of "big brother" with the hospital monitoring her progress. This suggests a need for **requirements 33-35** (the need for the user to specify privacy settings and information disclosure settings). Nevertheless, she believed that using it would improve her confidence. As for instrumental attitude, one participant talked about how she used crutches during her recovery and believed that the FriWalk would have helped her to recover faster. She also said that she would like the system to link her up with people who were recovering from similar conditions in order to get support and encouragement. This endorses **requirement 16** which states that the system will collect health information in order to be able to link users together. It also suggests that **requirement 29** (The system should link users with similar interests that they wish to be matched on) be understood to include interests in meeting other people with similar health conditions.

On the issue of perceived control, one participant mentioned the need for an accessible UI. This links to **requirement 48** and suggests that it should be modified to specify that the interface should be customizable (Display accessible visual user-interface. Visual impairments must be considered. *The interface should be customizable*.). The participant said,

> *Visually I think it would be hard to use that, but if you could link an audio with it as well, then in Isabella's situation, I think, again – well, you said, somebody suggested perhaps somebody with her, so I think maybe the ability to increase the font easily obviously would help, or maybe have somebody with you. Although you could hear what they were saying, you wouldn't necessarily be able to see on the keyboard or whatever to put instructions and things in.*

While she suggests an audio interface (**requirement 49**), the point relevant here is that she would like to be able to increase the font in order to be able to see it better. Some form of customization is necessary in order to accommodate users with different perceptual abilities.

Finally, to confirm the previous comments about privacy above, one participant said,

> *Interviewer: And if you had been offered a system like this during your recovery, would there have been any reasons why you wouldn't have used it?*
>
> *Respondent: I don't think so really, unless maybe people would think it's like a Big Brother type thing; that there's somebody watching you all the time. I think a lot of elderly people are – they still think IT is a bit like that – that someone can log into everything, get all my information, and follow me everywhere and do everything and hack into everything I've got. I know it probably wouldn't have any personal security information on, but they've got to know it's going to be totally safe.*

This reinforces the need to ensure that users are in control of their own information and know how it is being used.

Scenario 14: David

Lifestyle	David has recovered from a fracture and currently he is able to walk assisted by a normal walker.
Gap for activity/system intervention	However, he does not really want to get out of home because he is afraid of a new fracture and he feels insecure in crowded environments.
Recommendation	This morning he received a recommendation from his Fri-Tab consisting of a visit to the temporary exhibition on model airplanes, which he loves, at the Museum that is around the corner. This museum offers FriWalks for people

	like David, that need a walker and do not feel very comfortable in that kind of environments
Decision	He decided to give it a try.
Using FriWalk features	When David reaches the museum, he parks his walker and takes a FriWalk, where he connects his FriTab. The museum is huge and there are many people, so David selects on his FriTab the icon to start the navigation to the temporary exhibition. The best route is calculated. The system is able to detect that a corridor has been closed due to building works, so it skips that route, and selects a trajectory through a big hall. In the hall a group of people is converging on a new picture so the FriWalk avoids this area. When he arrives at the exhibition he moves freely through the halls and corridors enjoying the visit. He meets an old friend who is also fond of model planes and spends some time having a nice chat with him. David now wants to look for attendance personnel to ask some questions about the models and his possibility of buying some items at the store so he selects the attendant button on the FriWalk and is redirected to the nearest one. He finally decides to go to the shop, selects “museum shop” button and the FriWalk helps David reach there, where he buys some presents for his grandchildren.
Result	After that he goes back home. He has enjoyed the morning. David’s main activities are recorded and summarized and a short video is sent to his daughter who is the contact person in the system. She receives a video containing his father walking out of the home, reaching the museum, socializing and buying items. She is glad to see how her father is not getting isolated at home.

One participant discussed this scenario with reference to a friend who had fallen frequently and is afraid of going out. Only one suggestion stood out with reference to requirements:

> *Interviewer: Do you think that the system could be designed to persuade or encourage someone to go out?*
>
> *Respondent: If there was some sort of system that asked her how she was, “Today, do you feel confident enough to walk to the kitchen?” and she filled it in. You know, some days she would feel more confident.*
>
> *Interviewer: Okay and so if she was confident then it would encourage her to do that?*
>
> *Respondent: Yes.*
>
> *Interviewer: But it wouldn’t try to encourage her to do more than she felt confident to do?*
>
> *Respondent: Well, then it would build up. Once she’s walked to the kitchen, can she make it to the front gate?*

The key idea here is that the system should take the confidence levels of the user into account when recommending activities. As confidence builds up, the extent of the exercise can be increased. This suggests a refinement of **requirement 78**: Recommends exercises to users *in accordance with their confidence and ability* (addition in italics).

2.4 Discussion

Participants enjoyed watching the scenarios of the system being displayed. These scenarios helped to define requirements in the earlier stages of the project in line with other HCI research that uses scenario-based requirements generation (Potts, 1995; Sutcliffe, 2003). In this study we presented the scenarios via video animations to participants for the process of requirements refinement. Participants openly discussed whether they saw merit in the system for themselves or for people that they knew. In general, participants were enthusiastic about the system and no one was completely negative. The role of experiential attitudes was important and this shows the need

to ensure that user experience (UX) is placed at the heart of designing the system. Our goal is to design a system that is not merely functional, but provides an enjoyable experience for users.

3 Clinician focus group at Getafe University Hospital

For the refinement of the project's user requirement from a clinical perspective a focus group was carried out under the following guidelines:

- Small number of participants should be present to facilitate discussion
- Presence of a moderator to run the session
- Aimed at a discussion instead of on individual responses to formal questions.

A focus group was held with professionals working with people in the clinic. Following the guidelines of the hospital, this work did not require ethical committee approval.

3.1 Method for focus group with clinicians

The focus group was to run for a maximum of 3 hours. Discussions on each scenario should not be much longer than 15-20 minutes. Cards were completed by the participants, ACANTO researchers took detailed notes of the discussion for later analysis.

PHASE 0 (introduction and information gathering)

Before starting the focus group, the aim of the session is explained to participants. Also some evaluation cards (see Appendix 4) are provided with the aim of collecting individual opinions/suggestions on each of the scenarios presented. For each scenario, the following individual information is asked to the participants:

- Clinical utility.
- Weaknesses.
- Strengths.
- Suggestions.

PHASE I (Project presentation)

In this phase a short presentation about the ACANTO project is presented to the participants. Also, as the scenarios to be validated are those related to rehabilitation, social-related ones are quickly presented to provide a general idea of the whole project (see Appendix 5).

PHASE II (FriWalk presentation)

After the participants have a general idea of the project, the device itself (FriWalk) is presented. Some demonstration exercises take place; also, volunteers can use it under supervision (see Appendix 5).

PHASE III (discussion forum)

Under the moderation of one of the ACANTO's researchers a discussion starts (see Appendix 5). This section is structured as follows:

1. An animation that describes the scenario to be discussed is played. Five scenarios are analysed:
    - Rehabilitation and social use.
    - Functional decline.
    - Rehabilitation after hip fracture.
    - Rehabilitation tracking.
    - Diagnostics tool.
2. The target scenario is recapitulated by putting into more formal words what was presented through the animation.
3. An interactive discussion starts.
4. Enunciation of the agreed conclusion (if reached).

Participants

Nine professionals participated in the focus group (see Table 3). One participant did not have an occupation apparently related with the problem domain (a nutritionist) but was invited to participate in order to also consider the opinion of a professional independent of the specific project area but with experience in the general research area.

Table 3: Participants' professional profiles

Professional profile	Number of participants
Geriatrician	5
Nurse	2
Physiotherapist	1
Other	1
	9

3.2 Results

Tables 4 to 8 present a combined evaluation of the different scenarios summarised from the individual discussions of the professionals in the focus group and any information provided on individual cards (see Appendix 6 for individual cards data). Participants commented on clinical utility, the perceived weaknesses of the proposed solution, perceived strengths, and made suggestions for improvements

Table 4: Combined evaluation: rehabilitation and social use

REHABILITATION AND SOCIAL USE (use case 10)		
Summary of comments from focus group		**Requirement**
Clinical utility	It is a good method for rehabilitation monitoring.	
	It is a good tool to monitor patients at home while on the waiting list for rehabilitation.	
	It is possible to perform rehabilitation exercises out of the clinical environments, optimizing rehabilitation time.	
	It is useful to maintain physical activity.	Measure physical activity in evaluation
	We can assess the gait pattern helping the diagnoses of falls	72
	It is a good tool to improve functionality and to encourage going out of the home through FriTab.	54 – including outdoor time
	It is good to empower patients' confidence.	Test confidence/self efficacy
Weaknesses	It does not seem that it will be beneficial, from a rehabilitation point of view, for people who can actually walk at home or indoors without the help of a walker.	New requirement 101: Use of the walker should not interfere with normal walking pattern (i.e. length of stride) New requirement 102: The Marketing materials should position why you would use it if you don't need a walker
	Architectural barriers in the patient's home must be known and assessed. Homes must be evaluated.	New requirement 103: Pre-use evaluation of i) home/care home environment to assess suitability ii) environment where diagnostic tests being carried out
	It could be difficult for patients with sensory deprivation to use the system.	Requirement 48, 49, 50
	It is minimally invasive.	86, 101
	It is a good tool to regain confidence and reduce the fear of further falls, as the patients have a support mechanism.	
Strengths	It can be useful to widen the life space.	54
	Feedback to monitor the exercises program is provided.	72-76
	Useful to continue the rehabilitation at home.	Aim: Support rehabilitation at home
	It is a good tool to assess independence recovery	72-76
	The walker improves patient safety, adjustment disease and the social isolation caused by falls.	
	It is very supporting after the fall and for the fall syndrome; it provides a great help to walk.	
	It can improve perception so that the patient gains confidence.	
	It provides support both to rehabilitation and social activities.	
	The walker should have two emergency buttons, one for calling for help and another for stopping the system if it is running.	New requirement 100. New requirement 104: System should raise alarm to local support staff on request from user or after a prolonged delay.
	In the early stages of rehabilitation, the exercises program should be monitored by a physiotherapist, physician or occupational therapist, as there exist some risks. Also, patients need to be trained	New requirement 105: Training will be required for clinicians, care home staff and users. New requirement 106: A Clinician interface will be provided for a) use of walker during diagnostics b) to assess diagnostic and rehabilitation test results.

Suggestions	It would be necessary to make a preliminary assessment of the places where the walker will be used	New requirement 103
	To improve gait pattern in patients with Parkinson disease, it would be an option to play a sound in order to provide patients cues to help the gait.	New requirement 107: Parkinson walking audio cues option (nice to have)
	The stability of the walker is very important, perhaps non- parallel wheels would help.	63
	The walker should be focused on a strictly temporary use.	Assumption: Not for permanent use as rehabilitation aid.

Table 5: Combined evaluation: functional decline

FUNCTIONAL DECLINE (use case 11)		
Comments summary		**Requirements**
Clinical utility	It is a good method to present and manage exercise programs.	New requirement 108: Support trained personnel to administer the SPPB diagnostic tests and record results.
	It is very useful to guide the patient through the neighbourhood and adaptation to new environments can be enhanced.	
	The walker is useful for its social and emotional use.	
	It can be helpful to regain confidence	
	It can be useful to treat the adjustment disorder because of the social activities that the system can propose.	
Weaknesses	As the scenario is described, the walker does not seem necessary. It would be very useful to show the user his/her new environment.	
	The name of the scenario does not seem correct.	Rename the scenario
Strengths	It is possible to record the compliance of the exercises program, so the doctor can monitor what the patient is doing.	Record compliance and provide feedback to clinician. 54,55,78
	If the patient performs the exercise program, his/her fitness will be improved.	
	It is useful to help users know new environments; the walker can help improving the adjustment disorder	
	It can provide the user social support with new activities.	
Suggestions	Change the name of the scenario from functional decline to adjustment disorder.	
	In this case, the walker should be used to walk outside of the nursing home, not inside. Prescribers should not necessarily be a geriatrician.	New requirement 109: The system should be usable in an outdoor environment (nice to have)
	In this scenario, the staff of the nursing home should be responsible for managing the process.	New Requirement 105: Training materials for nursing home staff.
	Nursing home personnel have to teach the users how to use the walker.	New Requirement 105: Training materials for nursing home staff to teach patients.

Table 6: Combined evaluation: rehabilitation after hip fracture

REHABILITATION AFTER HIP FRACTURE (use case 12)		
Comment summary		**Requirement**
Clinical utility	It is a good tool to channel feedback between patients and doctors. It is possible to control the exercise program, this way, new exercises may be prescribed and is also useful in the final stages of rehabilitation.	
	It is a good tool to perform rehabilitation at day centres.	
	It is a good tool to maintain adherence to the prescribed treatments.	
Weaknesses	The walker cannot be used in early stages of the exercise program without proper supervision (physician, physiotherapist, occupational therapist); professionals have to teach patients on how to use the system to minimize risks.	Requirement 106:
	The walker should be left as soon as possible and the patient should be moved to other technical aids in order to improve the physical independence.	
Strengths	The walker helps with independency.	
	The feedback is provided to both physicians and patients.	**72-77**
	It allows physicians to access the information related to the exercise program. It is a good tool for patient evaluation.	
	It can improve muscle weakness by means of the exercise program.	
	The system can help improving adherence to the treatment through the provided feedback.	
	Patient progression can be assessed thanks to the monitoring system	
Suggestions	The physician must instruct the patients in walker use.	105
	Professionals need specific training on the walker.	105
	The walker should be focused on a strictly temporary use to improve physical performance.	
	The walker could have a heart rate sensor to monitor patient's status.	New requirement 110: Monitor heart rate (nice to have)
	It would be a good idea to play explanatory videos explaining the patients how to perform a specific activity.	105 New requirement 111: The user lead-through should instruct the user on how to complete the exercise properly (this may require video or animation)
	In this scenario, the staff of the day centre should be responsible for managing the process.	

Table 7: Combined evaluation: rehabilitation tracking

REHABILITATION TRACKING (use case 13)		
Comment Summary		**Requirement**
Clinical utility	The feedback provided to the professionals is of great clinical interest.	
Weaknesses	The walker should be for a limited period and the patient should be moved to other technical aids as soon as possible in order to improve the physical independence.	
	It is necessary to train the professionals not only at the nursing home but also in other clinical scenarios.	105
	The responsibility of the process is not clear for this scenario.	
Strengths	Feedback is provided to both physicians and patients.	54, 55,72, 73, 74, 75, 76,77
	The patient can be encouraged to adhere to the treatment and thus to regain functionality earlier	
	The capacity of the system to report that the user is not performing the prescribed therapy.	New requirement 112: Raise report to clinician if therapy is not being followed.
	It is a good way to communicate among professionals	

Table 8: Combined evaluation: diagnostics tool

DIAGNOSTIC TOOL (use case 15)		
Summary of Comments		**Requirements**
Clinical utility	It could be useful to assess patients' gait speed.	72,74
Weaknesses	It seems difficult to integrate the walker into the existing tests (for instance, for the SPPB the walker does not seem useful in the balance test and the chair stand test, and to perform the gait speed test it would be necessary that the patient walks with a walker daily).	Follow up workshop required to ensure effective integration.
	The walker modifies the gait speed so that the results are unreliable. It is only useful if the patient uses a walker daily.	101
Strengths	The walker could provide higher accuracy in the measurements.	72-76

Suggestions	It could incorporate a gait speed sensor to assess the patient's progress in the rehabilitation treatment.	74
	It could be useful for monitoring the patient's progress within the prescribed therapy.	

3.3 Conclusions from clinician focus group

Rehabilitation and Social Use

The clinicians reached the conclusion that the FriWalk is a good tool to perform exercise programs at home, to monitor the rehabilitation process, to provide feedback and to maintain physical activity. This provides the capacity to improve functionality, which empowers patients' confidence, allowing them to leave their home environment.

The main drawback identified is the specifics of the patients' homes (obstacles, corridors' widths, etc.); a good idea would be to perform an assessment of the home where the system would be used. Another point to consider is that the rehabilitation must be supervised (physicians, physiotherapists, occupational therapists) in the early stages in order to help the users using the system and perform the prescribed exercises.

Finally, the participants reached consensus regarding the need of the walker to have an emergency button (it must be taken into account that the user is probably using the system alone) and that the device should be withdrawn as soon as possible to foster patients' independency.

Functional Decline

The clinicians evaluated the walker as a good tool to perform exercise programs to improve functionality and restore confidence, which has great benefits in the social sphere. Nevertheless, the main concern that appeared was that the scenario is not correctly formulated: this is not a case of functional impairment but a case of adjustment disorder, in which the FriWalk could have a great impact if it is used to help the older adult to become familiar with his/her new environment. The group proposed that the scenario should be reformulated to set the nursing home staff as the case managers who follow the process (although the geriatricians at the hospitals are the initial prescribers).

Rehabilitation after Hip Fracture

The clinicians evaluated this scenario as providing a good tool to gain adherence to the prescribed rehabilitation treatments since the process can be continued at a day centre after the patients are discharged from the hospital. Again, the clinicians highlighted the need to rethink who is responsible in following the process once the patient leaves the hospital: they propose to set the staff of the day centres as the case managers (although recommendations from the geriatricians at the hospitals can be followed). Also, the temporary use of the walker was stressed.

Rehabilitation Tracking

The clinicians highlighted the great potential of the communication system, which could have tremendous impact on the adherence of the prescribed rehabilitation treatments. The main concern was the lack of clarity in relation to the 'owner' of the process in this scenario: the geriatrician at the hospital or the staff of the nursing home. It is proposed that the professionals at the nursing home are set as the case managers while the geriatrician at the hospital acts as the consultant.

Diagnostic Tool

The clinicians identified many drawbacks, mostly related to the modifications that the walker introduces in the gait while a subject is using it; for this reason, it would only be useful as a truly diagnostics tool either for those patients who use a walker daily or in the case the device do not interfere with the person's walking. For this use case, given the technical features of the walker version that was presented to them when the focus group took place and as the number of patients that use a walker is not high enough, the professionals reached to the conclusion that the scenario should be removed.

However, after the clinical workshop held in Getafe (Spain) the 15th and 16th September 2016, when the new prototype of the walker was presented, clinical professionals agreed to reinstate this use case. The new version of the FriWalk is able to walk behind the subject while he/she is walking or even remain static and still perform the required measurements so it does not interfere with the patients' walking pattern.

3.4 Modification proposals

The clinicians proposed modifications for three out of the five analysed scenarios. They also proposed removing the scenario related to the use of the FriWalk as a pure diagnosis tool (they are open to re-include this scenario if the device does not interfere with the person's walking). Tables 9 to 12 show the new proposed scenarios, where the modifications made to the original ones (defined in Deliverable 1.6) are written in red. In addition, a new scenario related to functional decline was proposed (Table 13).

Table 9: Proposed modification to rehabilitation and social use scenario

REHABILITATION AND SOCIAL USE	
Demographics	Manuel is a 74-year-old man who lives alone.
Location	He lives in an apartment in Madrid.
Lifestyle	He recently suffered a bad fall which has made it difficult for him to get around. He is undergoing therapy at a local falls clinic and is slowly getting better. The clinical staff goes to Manuel's home to assess the barriers and obstacles in his home and to see if it is possible to prescribe a FriWalk and how the treatment should be adapted. At the clinic Manuel is given a FriWalk to help him move around and to give him exercises to perform at home.
Gap for activity	Back at home, Manuel is now afraid to go out. He worries that he might fall with no one to help him.
Desire for activity	He would like to go back to his local museum because he has not been there since his fall.
Recommendation	One day, the FriTab on his FriWalk says that he should go to the local museum. It tells him that his friend, Francisco, who also has a FriTab, is going to the museum and they could go together.
Basis for recommendation	Every day, the FriWalk has asked Manuel to do exercises to help improve his balance. It has noticed that his balance has improved. It thinks he will be able to go out without the help of his FriWalk.
Decision	Manuel agrees to go to the museum. He feels reassured by the help of his friend.
Implementation	The next day, Francisco visits Manuel's house and they walk to the museum together.
Result	They both enjoy their visit to the museum. Because Manuel can see where his friends are going on his FriTab, he decides he will try to go out with them more often.

Table 10: Proposed modification to functional decline scenario

ADJUSTMENT DISORDER	
Demographics	Manuela is an 83-year-old woman who lives with her husband
Location	She lives in a nursing home with her husband in Getafe, Madrid

Lifestyle	She has been slightly depressed since she and her husband moved to the nursing home. She has lost some sight during the last years, and she does not know her way around the new neighbourhood or the venues and activities there.
Gap for activity	She is unmotivated, she does not know the surroundings of the nursing home where she is living and does not feel confident enough to go outside the nursing home without her husband.
Desire for activity	She would like to feel more confident to perform activities on her own, and to regain some independence.
Arrival of system	After Manuela visits with Dr. Sánchez, her geriatrician, she tells him that she is depressed and unmotivated since she moved to the nursing home. Dr. Sánchez knows that Manuela lives in a nursing home that has some FriWalks. Dr. Sánchez sets up an exercise plan for Manuela that she can do at the nursing home; he also recommends her to go outside with the FriWalks to buy, have a coffee, to go to cultural places, etc. so she can get familiar with her new neighbourhood (the FriWalk provides Manuela directions of places of her interest and help her getting there).
Using FriWalk features	Some mornings, while her husband is out with their friends, Manuela goes to the gym in the nursing home. The nursing home counts on 2 FriWalks that are shared among all residents subscribed to an exercise program. When one of the FriWalk gets available, Manuela takes it and "logs in". The FriWalk guides her through her exercise program. Once she finishes, the FriWalk asks her how she has been. With the help of the FriWalk Manuela also goes outside and starts to know the new neighbourhood which makes her improve her mood.
Recommendation	After performing an exercise session at the nursing home, the FriTab in the FriWalk tells Manuela that a group of people from the nursing home will be attending a watercolour expo near the nursing home, in a venue she did not know.
Basis for recommendation	Manuela has regained a good functional status, and she should start doing activities on her own.
Decision	Manuela has regained a good functional status and feels more confident about her walking capacities, so she agrees to go to the watercolour expo.

Table 11: Proposed modification to rehabilitation after hip fracture scenario

REHABILITATION AFTER HIP FRACTURE	
Demographics	Jose is an 80-year-old man who lives alone
Location	He lives in a small, old flat in Getafe, Madrid
Lifestyle	José was quite active before the fracture, and enjoyed going in the morning to a bar near his house with his friends.
Gap for activity	José is feeling some pain when he walks, and he does not know how much exercise would be good for him.
Desire for activity	José has the idea that everyone he knows that has suffered a hip fracture has died in the following year, and he is scared it might happen to him.
Arrival of system	José starts using the FriWalk in order to stand up and walk through the hospital alleys. When he is discharged, the geriatrician recommends José with a Day Centre near his house where they have some FriWalks, as José lives far from the Hospital and it would take him too long to follow the exercise program at the Day Hospital. The geriatrician then sets an exercise program for José.
Using FriWalk features	José goes to the Day Centre three times per week early in the morning. He is monitored by the personnel at the Day Centre (physiotherapist, occupational therapist or physician), who will be responsible for his exercise program. José uses the FriWalk to perform the recommended exercise program. He can also notify Dr Sánchez whether he feels pain or not, and how tired he has felt after the exercise.

Basis for recommendation	It is extremely important to regain a good level of functional capacity after a hip fracture in order to avoid disability and even death. Factors that might hinder the performance of exercise include pain or fear or falling, so the FriWalk can help to relieve these.

Table 12: Proposed modification to rehabilitation tracking scenario

REHABILIATION TRACKING	
Demographics	Ana is a 76-year-old woman that has some blood pressure problems. She lives in a nursing home and needs a crutch to walk.
Gap for activity/system intervention	One day she went to the supermarket and did not see the step of the sidewalk. She felt and broke her hip. She was taken to the hospital and had to wait 4 days to have an operation, since she was taking medicines for the blood pressure and the treatment had to be interrupted. She spent 3 more days at the hospital after surgery, and when the surgery wounds allowed it she went to the functional recovery unit for rehabilitation instead of going back to the nursing home as she was not able to stand up immediately.
Arrival of system	After the rehabilitation at the hospital she can stand up with a FriWalk. She has received training on the type of exercises she has to do with the FriWalk and she goes back to the nursing home.
Using FriWalk features	She must perform a series of exercises that are prescribed by the nursing home clinical staff every day and the summary of those exercises will be reported to the geriatrician. An alarm is risen to the geriatrician because Ana is not doing her exercises. She feels unmotivated after the fall, because of the pain she feels and also because she is afraid of falling again. The geriatrician contacts the nursing home personnel and they try to educate and motivate Ana to do the exercises.
Result	She feels better after this talk and in the subsequent revisions one month (surgery) and three months the geriatrician realizes that she is improving. The monitoring continues until she goes back to the hospital for the revision, after one year from the surgery. She is able to do the same activities she did before the fall, using the FriWalk. Without being monitored with the FriWalk, probably the rehabilitation would have taken more time and this woman would have not recovered well from the fracture.

Table 13: New scenario: functional decline

FUNTIONAL IMPAIRMENT	
Demographics	María is an 80 years-old lady who lives with her husband.
Location	She lives in an apartment in Getafe.
Lifestyle	Every day María walks with her dog; also she goes to dance classes with her husband three times a week. She began to feel ill, experiencing dyspnea and being unable to walk properly, so she went to emergency. María was admitted in the hospital and was diagnosed with a heart failure so she could not walk for a few days.
Gap for activity	When María feels better and her dyspnea has improved, she tries to walk, but she cannot do it since she has lost strength in her legs. Her doctor performs an evaluation and considers that she must do physical activity to regain functionality so he prescribes her an exercise program at the day hospital where there is a FriWalk available.
Desire for activity	She would like to go home to walk her dog and return to the dance classes with her husband as soon as possible.
System intervention	Every day, while in hospital admission, she goes to the day hospital and uses the FriWalk with the supervision of the occupational therapist, who guides her through the prescribed exercise program. María start realising that she is regaining strength in her legs. Her functional status has substantially improved so she can return home. After María is discharged she keeps going to the day

	hospital three days a week so she can continue with her exercise program. She feels better every day.
Result	María regains both the confidence and the functionality so she goes out again with her dog and starts again dancing classes.

3.5 Summary of Clinician Focus Group

The following overall conclusions have been extracted:

i. All participants agreed that after the walker is prescribed it is not clear who is the responsible for the treatment. Currently, the responsible personnel depends on the level of care, while the patient is at a hospital, the geriatrician is the responsible, but when the patient transfers to the care of a day centre, a falls clinics or to a nursing home, the responsibility is shifted to their specific staff (geriatrician, rehabilitator, physiotherapist or occupational therapist). A new question arises with the incorporation of the FriWalk: who is the responsible for the treatment after the FriWalk is prescribed by a physician? The clinicians concluded that the monitoring must be managed by the personal responsible according to the care level, but that the geriatrician controls the evolution of treatment as the patient progresses. As all data are available, access to information is facilitated, allowing the geriatricians at the hospitals to make recommendations about the treatments if is necessary.
ii. Another point of discussion was in the use case related to using the system as a diagnostic tool. All participants agreed that the FriWalk does not seem a good tool to assess the gait, gait speed and SPPB since the device interferes with the walking; regarding stand-up analysis, the walker's seat should be configurable in order to meet the test criteria. The main limitation found is for those patients that do not use a walker daily: their gait using the walker would be unreliable because it would be affected by the use of the device itself. Although the FriWalk is not considered to be useful as a pure diagnosis tool it is considered relevant for assessing patients' rehabilitation evolution. The focus group suggest that the status of the current prototype is not sufficient to fulfil this scenario and more work is required.
iii. All participants highlighted that for the whole set of evaluation scenarios, the FriWalk is an excellent tool to monitor exercise programs and to prescribe treatments. It is of great clinical interest to have information related to the evolution of the patients available. It is important to allow remote access by the professionals to the patients' data on how they are performing with the prescribed therapy so certain events can be detected and tackled (for instance, in Ana's scenario, her geriatrician can remotely see that she is not doing her prescribed exercises so he calls the nursing home personnel, etc.).
iv. A new scenario related to a more realistic case of functional decline was included.

4 Focus group with Older adults at HUG

4.1 Method

In this case, the same premises as for the focus group carried out with clinical professionals apply: A small number of participants took part in a group discussion, facilitated by a moderator. The moderator aimed to facilitate discussion while individual responses and thoughts were captured on note cards. Table 13 shows the protocol followed within the session. The session lasted a maximum of 2 hours. Discussions on each scenario were limited to 15-20 minutes to ensure all scenarios were discussed. Required ethical approval from the Getafe University Hospital was obtained prior to the development of this focus group.

PHASE 0 (introduction and information gathering)

Before starting the focus group itself, participants are explained the target of the session. Also, in order to gather information on each participant, questionnaire is filled up individually (see Appendix 7).

PHASE I (project presentation)

In this phase a slight presentation related to ACANTO project is presented to the participants. Also, as the scenarios to be validated are those related to rehabilitation, social-related ones are quickly presented to provide a general idea of the whole project (see Appendix 8).

PHASE II (FriWalk presentation)

After the participants have a general idea of the project, the device itself (FriWalk) is presented. Some demonstration exercises take place; also, volunteers can use it under supervision (see Appendix 8).

PHASE III (discussion forum)

Under the moderation of one of the ACANTO's researcher a discussion forum starts. This section is structured as follows:

1. The scenario is presented and the participants have to choose (individually) a known person (maybe themselves) that they identify with most. In this way, the older adults will be best placed to answer the questions on the motivations of those persons to use the system or their experiences in using it. Three scenarios are analysed:
    - Rehabilitation and social use.
    - Adjustment disorder.
    - Rehabilitation after hip fracture.
    - Functional decline
2. An animation that describes the scenario to be discussed is played.
3. After watching the scenario through once, the scenario animation will be paused at two specific points and the interviewer will ask the participant about the problems and opportunities the user faces (first point) and reasons why the user may/may not use the system (second point). To answer these questions participants will give open answers. The questions to be asked for each scenario are:

    After the description of the person

    a) What problems does your friend (or you) face?
        - How well do you think the system solves these problems?
        - Do you think that the system should be changed to better meet these problems?
        - What abilities does this person/you/your friend have that the system can encourage?

    b) After arrival of the system (or similar)
        - Why would this person/you/your friend use this system?

            i. How would the system make the person feel?
            ii. What might the person gain from using the system?
            iii. How would other people's views affect the user's willingness to use the system?
            iv. How would it affect the user's willingness to use the system if other people used it?

v. What sort of things might help the person to use the system?
vi. What sort of things might make it hard for the person to use the system?
vii. How important is it that the person finds it easy to use the system?

- Why would this person/you/your friend not use this system?

4. An interactive discussion starts.
5. Enunciation of the agreed conclusion (if reached).
6. Finally, it will be attempted to have the participants propose a new scenario in which they can picture themselves using the system.

Participants

Eight elderly people participated in the focus group, which were from 80 to 92 years old. Most participants had a low education level, all of them adopt a healthy lifestyle and most of them perform physical activity like walking. Only one participant uses a smartphone.

4.2 Results

Rehabilitation and social use

The older adults concluded that the patients' main problem is their need to have someone to help them perform basic activities and fear of going outside alone. The FriWalk could help regain confidence by encouraging physical activity and helping avoid obstacles (Requirement 11, 57,59). All participants believe that the Fri-Walk is a good tool for this use-case.

Functional decline

The main problems of patients are that they do not know where they can go, and their vision limits ability to walk alone, a situation that will affect mood. The FriWalk could help restore confidence to do outdoor activities, but the Fri-Walk should have a voice option for patients with a visual deficit (requirement49).

Rehabilitation after hip-fracture

The participants agreed that during rehabilitation after hip-fracture, a patient has a sedentary lifestyle, and the Fri-walk could help obtain more freedom to go outside, improve fitness and decrease fear of falling. They thought that with the FriWalk the patient could be more independent.

Rehabilitation tracking

In the rehabilitation tracking scenario, the participants considered that the patient could be unmotivated and the FriWalk could help encourage physical activity by providing feedback about the improvements made in her physical performance.

4.3 Discussion of rehabilitation patients focus group

The focus group participants agreed that the FriWalk is a good tool that could help elderly people in their daily life, since they could improve their confidence and the patients could become more independent.

They are concerned about security, and they consider that it is an important point to improve the confidence and decrease the fear of going outside alone. They also considered that the streets should be adapted to use the walker, so that there are not so many obstacles. They think that they would need help to learn how to use the Fri-Walk.

Unexpectedly (researchers had the a priori idea that the older adults could consider the system as stigmatizing), the participants considered that end-users would be willing to use it and seeing other older adults using the system would be encouraging for them.

The focus group proposed adding voice cues, voice control and traffic lights identification for people with visual deficit (requirement 49), and suggested the possibility of using the FriTab to answer phone calls. Another proposal was that the Fri-Walk should have an alarm button to improve the

confidence of the user. They think that if the FriWalk had a basket it could help them to do the shopping and carrying things around.

5 Clinical Requirements Workshop

This workshop was held in September at Getafe Hospital, to address the concerns of the clinicians regarding the diagnostic scenario, demonstrate the updated prototype and clearly identify all necessary steps to complete the diagnostic tests.

5.1 Method

Participants

In the workshop at least one member of each ACANTO partner was present. In addition, the following members of staff from the hospital: 6 x Geriatricians; 1 x Physical therapists; 2 x Nurses; 1 x Nutritionist; 1 x Economist; 2 x Engineers; and 1 x Engineering student.

Process

The workshop took place over two days. On the first day each team presented the Getafe team with the changes to the prototype and what the prototype could now achieve. On the second team the participants worked together to create draft use cases for each test and exercise. This process enabled the steps to be identified and to establish how the walker and the clinician would work together.

5.2 DIAGNOSTIC USE CASES: SPPB test

All the tests start with an instruction phase in which the patient is required to hold the grips, watch a small clip and listen. Then everything starts. We could also store on the map a cert of certified places where the environment conditions allow us to carry out the test successfully and have the robot check automatically if it is in one of these places. A time out mechanism must be used to detect that something has gone wrong with the test.

The SPPB tests will be supervised.

The test is in three phases.

- Balance Test
- Gait speed
- Chair Stand Test

Balance test

The walker stays in front of the patient and it is used to take measurements and as a potential support in case of balance loss. As soon as the patient touches the handle or moves any of the feet the test is failed/complete.

Notes

Instructions are given both through the visual interface and through the auditory interfaces. It is mandatory that the robot is firmly locked in case of falls. We need to detect when she/he touches the handles.

Task Steps

1. The robot is firmly stopped in front of the patient (brakes on)
2. The robot instructs the patient to hold the grips (allows positioning of patient).
3. The robot shows a video/animation showing how to complete the test and the correct positioning of the feet.
4. The patient is instructed (by the robot) to move their feet until they are in the correct position.
5. The test starts when the user's feet are in the correct position and they remove their hands from the grip.
6. The user is signalled to stop when the max time has elapsed (visual and auditory)
7. The test is stopped if the user grips the handles, moves their feet, or max time has elapsed.
8. The time that the user maintained balance is used to calculate a score (see score sheet)
9. The date and score for this test is recorded in the patient record (see Figure 3)

10. The user is thanked for taking part.

Gait speed

We have two cases: A. The patient is able to walk autonomously, B. the patient has to use the walker.

Notes

For the purpose of this project, there will always be a supervisor with a STOP button in easy reach on the tables and with a safety able in the end that is connected to a magnet switch to power off the system.

We will use foot recognition to mark start and end.

Case A: Autonomous Walking

Steps

1. The robot is firmly stopped in front of the patient (brakes on)
2. The robot instructs the patient to hold the grips (allows positioning of patient).
3. The robot shows a video/animation showing how to complete the test
4. The patient is told to position themselves in front of the robot by starting to walk in front of the robot until they are told to "STOP"
5. After a few seconds: they are instructed to GO.
6. The system detects the time the first foot crosses an ideal line.
7. The robot starts following the human. When four metres distance is completed the robot says STOP
8. The robot records the time the second foot crosses the line.
9. If the patient does not succeed (stops walking) the robot detects this and the test is stopped
10. The exercise is repeated twice (repeat only if previous repetition successful)
11. The system records the date of the test and the best time to complete 4m. This is converted into a score (see Figure 3)
12. The patient is thanked for taking part.

Case B: Robot Assisted Walking

Steps

1. The staff position the robot so that there is sufficient space and aligns the walker with the wall (a straight 4m is required)
2. The robot is firmly stopped in front of the patient (brakes on)
3. The robot instructs the patient to hold the grips (allows positioning of patient).
4. The robot shows a video/animation showing how to complete the test
5. The patient is told to position themselves holding onto the grips
6. After a few seconds: brakes are released and they are instructed to GO.
7. The robot walks straight until the distance is covered and the test is stopped and time noted.
8. The exercise is repeated twice
9. The system records the date of the test and the best time to complete 4m in the patient record. This is converted into a score (see Figure 3)
10. The patient is thanked for taking part.

Chair Stand test

Description

The patient is required to stand up and sit down 5 times. This must be completed as quickly as possible with arms crossed across chest.

Steps

1. The staff position the robot in front of a suitable chair
2. The robot is firmly stopped in front of the patient (brakes on)
3. The robot instructs the patient to hold the grips (allows positioning of patient).
4. The robot shows a video/animation showing how to complete the test.
5. The robot instructs the patient to sit down and wait for the start command
6. The robot puts itself in the optimal position to take the measurement.

7. The robot says STAND UP and SIT DOWN PLEASE to make sure that the patient is able to reach a full knee extension with arms crossed.
8. If the patient qualifies she/he starts the real test (if not the test is ended)
9. The robot says SIT DOWN and then GO and the person makes 5 repetitions.
10. The system records the time that the patient spends carrying out the 5 repetitions (turned into a score see Figure 3), or if the patient is unable to do the exercise.
11. If the user does not complete the stand-up/sit down within x seconds. The test is stopped.
12. The patient is thanked for taking part

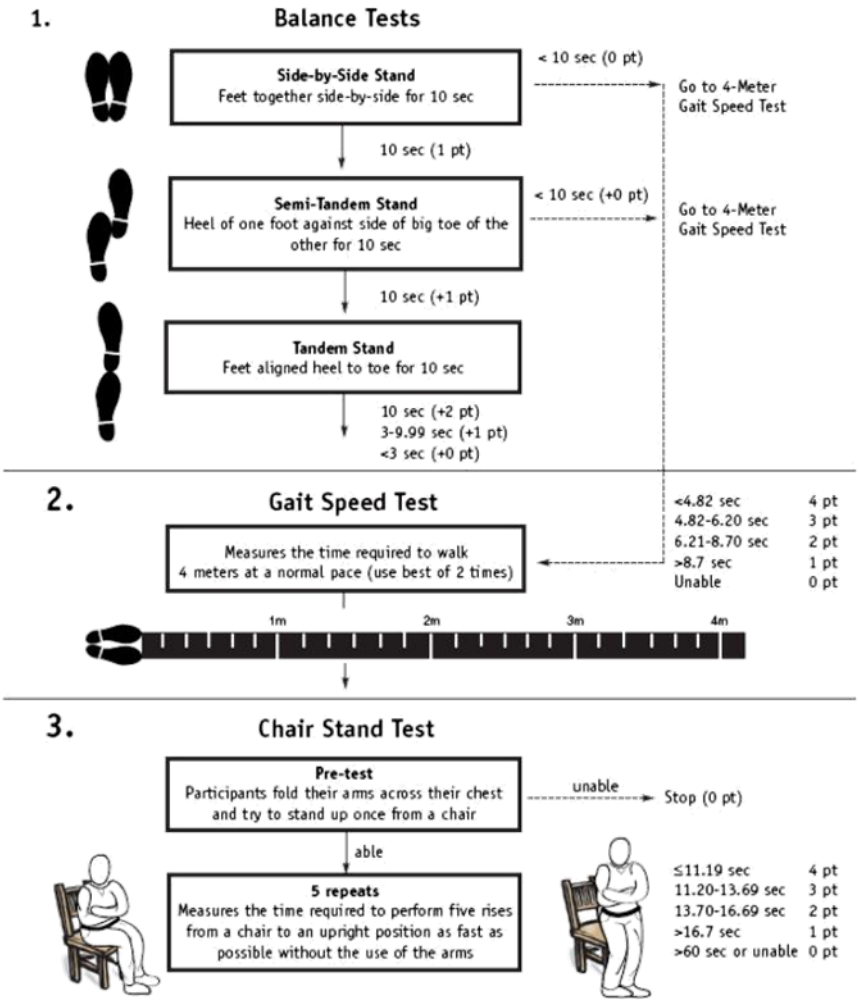

Figure 4: Scoring chart for SPPB
(Riskowski, Hagedorn, Dufour, & Hannan, 2012)

OG Exercises

For all OGx exercises we assume that the patient receives an invitation on the tablet, which has to be accepted only if a care giver is available.

Desirable feature: obstacle avoidance with no previous plan.

OG1: Walk x minutes / one hour

1. The walker is located in the room of the patient.
2. The patient receives a reminder You should walk from the tablet.
3. If she/he accepts the invitation, she/he goes to the walker.
4. The system is powered up. The patient is asked to hold the grips.
5. The patient will be shown a video/animation of the task of going for a short walk for x minutes.

6. The patient is asked to press a button when they are ready to walk and then take hold of the grips.
7. As soon as the patient touches the grips, the exercise begins.
8. A timer is displayed which tells the patient how much time has elapsed since she/he started to move.
9. When she/he moves the system records that she/he is moving.
10. when the patient has walked half of the prescribed time, the walker should tell him/her to start coming back to the starting point.
11. When x minutes of walking time are counted, the system tells the user that time is up.
12. If the wheels have not moved for a time-out time, we assume that the exercise is finished.
13. When the test activity is stopped (either non walking or full time) data gathering is stopped and the patient is asked to record how much pain they felt while doing the task (0-10 scale). This is added to record – pain perceived.
14. The user is thanked for taking part in the walk and reminded that walking is beneficial to their health.
15. During the walk we record:

- Gait analysis.
- Speed profile.
- The best (highest) average speed obtained in 6 meters of continuous walk (among all the 6 m of continuous walking detected).
- Distance walked.
- Time walked.
- Pain (even measured at the end of the exercise).

OG2: ISOMETRIC/ISOTONIC exercise

Description:

This test requires the patient to fully extend and hold each leg alternatively for a specified number of times.

This test is not run independently by the robot, it is a collaboration between the robot and the carer. In this instance the interface is for the care giver.

Pre Use

The system is set up for the patient and the configurable parameters have been set

- Number of repetitions.
- Maximum tolerable knee angle for the stretch phase.
- Time in which the position is held.

Steps:

1. The patient is invited to sit on a chair.
2. As soon as she sits, the care giver positions the system at side of the chair and selects ISOMETRIC exercise from the menu and selects the patient details (gets number of repetitions required)
3. The system gives an OK to the care giver on the display to begin.
4. The system says START. The patient lifts up and down the leg n times alternating left and right.
5. The system decrements the counter for each successful repetition. The display shows the count for each leg with the number of lifts remaining. The current leg is shown in green.
6. If the patient moves the wrong leg, the counter is not decremented. The same if the extension is not reached.
7. When a person achieves the correct extension of the knee a tick is emitted. Then a timer is started. When the leg has been held up long enough, a new tick is emitted.
8. If the patient does not succeed in holding the position long enough, we simply record the time and decrease the counter and count the repetition as done.
9. When both counters reach 0, the system says DONE or if the supervisor presses STOP and the test is ended and the participant is thanked for taking part.
10. The patient is asked on a scale of 0-10 how much pain they experienced while doing the exercise.
11. Information recorded:

- The patient has completed or not.
- How much time it has taken.

- Number of failures.
- In how many cases, she/he could not manage to keep the leg stretched for the time prescribed –and time managed.
- Pain (even measured at the end of the exercise).

OG3: Stand up/down

Description:

The procedure to get started is the same as for OG2, except that the walker is positioned in front of the patient. Contrary to the SPPB test the patient is not required to keep the arms crossed on the chest; there isn't a maximum time to perform the exercise (apart from the time out defined in case the patient does not want to continue and quits).

Pre-use configurable parameters for patient:

- Number of repetitions.
- Tolerable angle.
- Number of times a day, Y
- Time that position should be held for

Steps

1. The patient is invited to sit on a chair.
2. As soon as she sits, the care giver positions the system in front of the chair and selects STAND UP exercise from the menu and selects the patient details (gets number of repetitions required)
3. The system gives an OK to the care giver on the display to begin.
4. The system says START. The patient stands up until they are told to sit down.
5. The counter is decremented every time the patient reaches a full stand up extension. The full stand up is measured looking at the knee angle. When the patient extends the leg within the prescribed tolerance a tick is generated and the counter is decremented. At the end the system says EXERCISE IS FINISHED.
6. The patient can ask for the test to be stopped, or the care giver can choose to stop the test by pressing the "STOP" button.
7. The patient is asked on a scale of 0-10 how much pain they experienced while doing the exercise.
8. The following information is recorded:•
- The patient has completed the prescribed repetitions or number successful.
- Time to complete the exercise.
- Pain (even measured at the end of the exercise).
- Number of failures (to fully achieve required knee angle)

T1: Walk 'x' metres / day at 'y' m/s.

Assumptions:

- The walker is booked for the patient during n hours a day.
- The patient receives periodic reminders about the distance he/she stills has to walk today.
- The walker will not move unless an activity is selected (default: brakes on)

Desirable feature:

Obstacle avoidance with no previous plan.

Configurable parameters for each patient:

- Daily distance.
- Speed range in which the patient should stay.
- Top speed.

Steps

1. The patient takes hold of the grips and sees the menu of options, selects "DAILY WALK".
2. The patient is told how far they need to walk to reach target.

3. The patient is asked if they are "READY TO START", if yes the distance to walk is shown alongside a speedometer with the recommended speed range shown in green.
4. If the patient walks much faster than the required speed, the walker should decrease the speed to a safe value by partially turning on the brakes and informing the user they should keep to the optimum speed range.
5. If the walker is stopped more than a certain time (to be determined) the activity stops so if the subject wants to walk again the DAILY WALK" option must be selected to resume the activity;
6. if the walker stops a time below this threshold, it assumes it was a resting/social stop. The user is asked if they will be continuing the walk. The brakes are put on until the user presses "Ready to start" again.
7. If the answer is no, or when distance is reached, they are asked to record their pain (0-10 scale).
8. We record:

- Distance walked.
- Time walked.
- Speed profile
- The best (highest) average speed obtained in 6 meters of continuous walk (among all the 6 m of continuous walking detected).
- Gait analysis.
- Pain.

T2: Standing on one leg

In this exercise the patient has to stand on one leg for a predetermined time; he/she can use both, one or no hands depending on the configuration.

Assumptions:

- The walker is booked for the patient during n hours a day.
- This exercise can be prescribed to be executed more than once per day. For instance, it has to be done first with both hands, 10 repetitions per leg holding the position 10 seconds.
- Later the subject has to do the same but using just one hand.
- The patient receives periodic remainders about the exercises that he/she stills has to do today.

Configurable parameters:

- Number of hands that can be used.
- Time that the patient has to stand per leg.
- Number of repetitions.

STEPS

1. The patient takes hold of the grips and sees the menu of options, selects "STAND ON ONE LEG". The walker asks the patient to hold both handles to make sure he/she is engaged for the explanation; once this position is reached, the subject is shown the prescribed configuration for the exercise along with an explicative video.
2. The patient is told to take hold of the grips and watch the video.
3. The patient is asked if they are "READY TO START"
4. The patient is shown how to position themselves and told to correct if required.
5. The exercise does not start until the patient is in the desired initial position (i.e. just one hand in a handler and the legs are in the right position) which is detected by the walker (one foot standing and certain required hands in handles).
6. The exercise is always bilateral (is performed with one leg after the other). Once the exercise starts, a countdown is shown so the patient knows when he/she can release the required position and, if it is the case, swap to the next leg.
7. If the patient does not keep the leg in the right position or he/she touches the grips and shouldn't, the exercise is stopped.
8. The patient is asked to score the amount of pain they experience (0-10 scale)
9. Information recorded:

- If the patient performs the exercise correctly (does not use the prohibited hand(s) and holds the position).
- Pain.

- Time that the patient is able to keep the standing on one leg position.
- Number of fails.

T3: Standing on the tiptoes

In this exercise the patient has to stand on the tiptoes; he/she can use both, one or no hands depending on the configuration.

This exercise can be prescribed to be executed more than once per day. For instance, it has to be done first with both hands, 20 holdings the position 15 seconds. Later the subject has to do the same but using no hands.

Assumptions:

- The walker is booked for the patient during n hours a day.
- The patient receives periodic remainders about the exercises that he/she stills has to do today.

Configurable parameters (pre-use):

- Number of hands that can be used.
- Time that the patient has to keep the position.
- Number of repetitions.

STEPS

1. The patient selects the standing on the tiptoes option, the walker asks the patient to hold both handles to make sure he/she is engaged for the explanation; once this position is reached, the subject is shown the prescribed configuration for the exercise along with an explicative video.
2. The patient receives guidance to position themselves properly.
3. The exercise does not start until the patient is in the desired initial position (i.e. just one hand in a handler and the legs are in the right position) which is detected by the walker (one foot standing and certain required hands on handles).
4. Once the exercise starts, a countdown is shown so the patient knows when he/she can release the required position.
5. If the patient does not keep the right position or he/she touches the grips and shouldn't, the exercise is stopped.
6. Patient is asked to record the pain they experienced during the exercise (0-10 scale)
7. We record:

- If the patient performs the exercise correctly (does not use the prohibited hand(s) and holds the position).
- Pain.
- Number of fails.

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Appendix 1: Interview schedule

Description of system

Participants are presented with the following short description of the system.

As part of a European project, we are developing an online social network for older adults that will link together people with similar interests. The aim of this system is to prolong the time that older adults can live independently, therefore improving their quality of life. When you use the network it will collect a variety of information about you which will form your profile. The system will use this profile to recommend personalised activities with recommended users you can connect with based on shared interests, location, age etc. The system will suggest things to do together and will suggest places to go. The aim is to design a system that is easy to interact with that will help people to be more physically active and socially engaged. The system also acts as a means of safe introduction to new people before you meet face to face.

A further aspect of the project is an intelligent walker which aims to improve the physical health of older adults. It will do this by monitoring a wide variety of physical aspects, such as balance and walking speed, to see how well that individual is walking. If walking ability declines (i.e. if balance becomes decentralised, or walking speed reduces) then the system will notify a health care professional in order to suggest ways this can be improved through the use of exercise activities, or feedback.

Outline

Present persona cards and ask user to select three cards that are most similar to themselves or someone they know well ("Please select three people who are most similar to you or to someone you know well."). Then ask, "Why are these people similar to you or someone you know well?"

Scenario interview questions

Play scenario once through and then on the second run, pause at specific points to ask questions.

Get participant to imagine that the person described is them or their friend/acquaintance.

After description of the person ask:

- **What problems does this person/you/your friend face?**
    - How well do you think the system solves these problems?
    - Do you think that the system should be changed to better meet these problems?

- **What abilities does this person/you/your friend have that the system can encourage?**

After "Arrival of system" (or somewhere similar):

- **Why would this person/you/your friend use this system?**
    - How would the system make the person feel?
    - What might the person gain from using the system?
    - How would other people's views affect the user's willingness to use the system?

- How would it affect the user's willingness to use the system if other people used it?
- What sort of things might help the person to use the system?
- What sort of things might make it hard for the person to use the system?
- How important is it that the person finds it easy to use the system?

- **Why would this person/you/your friend not use this system?**

Final question:

"Now that you have seen the different ways that the system could be used, we would like you to describe a short scenario in which you could potentially see yourself using the system. Can you imagine and describe a situation in which you would see yourself using the system?"

Appendix 2: Tables of analysis of barriers and motivators

These tables show the full IBM analysis conducted in Italy and the UK.

Italy

ID Participant	Scenario	Experiential attitude (Q3a_Q4)	Instrumental attitude (Q3b_Q4)	Injunctive norm (Q3c_Q4)	Descriptive norm (Q3d_Q4)	Perceived control (Q3ef_Q4)	Self-efficacy (Q3g_Q4)	Facilitators (Q2)	Barriers (Q1ab) SEP [4]	Suggestions
160815_001	Fatima	Likely to build dependence	Very useful if used navigation	Likely to use if recommended by medical authority	Likely to use if other people reported good experience	Good if it uses user's existing knowledge, fear of falling	Little confidence, helps if it is easy to use	Good if used for social activities e.g. church, having coffee or tea, women's guild, shopping.	P-Cost, P-Existing injuries, P-memory	
160815_002	Tom	Would give satisfaction, useful to people without interaction, makes him feel included and part of a community, initially apprehensive	Expects to meet new people with similar interests, invite current friends for activities, use for alert in an emergency	/	Likely to be influenced by what other people are doing	Fear of falling while trying to use device, needs help from person to guide them, system should have few buttons and simple menus	Depends on person, ease of use is really important, overwhelmed by technology	Good when person already has a lot of friends	P-Ageing, P-disability, some people have no time, IE- ack of enabling facilities, E-inadequate provision of social spaces for disabled people	
	Michael	Feel good with positive attitude	Encourage and motivate for exercise, connect to people with similar issues, more socially involved	Medical doctor	/	Needs to meet expectations, system should be reliable, general fear of technology, comfort	Some people are overwhelmed by technology	Always other people with similar issues	Socially isolated people who chose to be homebound	
160815_003	Isabella	Feel a loss of autonomy, steered around	Expects to get correct directions and navigational aid, give nav instructions for system to follow	Embarrassing in crows, negative stereotype of being old, disabled	Likely to use it if everyone with the same needs used it	Needs to be informed about it, must not move autonomously	Feels they are capable but could present a challenge to other users, needs to be simple	Going to talks and slides, making eating arrangements with friends	P- Visually impaired	
	Dorothy	Feel more confident	Provide confidence, give a level of independence, give sales information, get recommendations from friends	Embarrassment can be overcome by necessity	Nice to be part of a group, belonging	Screen is useful to receive information	Computers usually do not perform as instructed, driving can be demanding	Self-confidence enables user to try new things	/	
160816_001	Dorothy	Excited, feels accommodated, enhances motivation,	Assist with time management, used for planning, assist with nav to restroom/toilet	Public embarrassment, fear of hurting others with FriWalk, stigma, social credibility	Not really effected	Needs to have an audio alert with a pleasant sound, needs to be compact and transportable dimensions, expert help needs to be available all the time,	Confident of ability to operate system, must be simple	Supporting for lone activities, supporting passion for music, member of blind and visually sighted group.	P-Often gets lost P-Effects of medication gives discomfort P-lack of motivation P-Pain P-Overcautious, worries a lot	

[4] S - System; E – Environmental; P – Personal.

						offer lessons on using it				
	Isabella	Enhances confidence, enabling, improve productivity, boosted confidence, feeling supported	Have updated information on public services e.g. Bus times, provide a seat to rest, eating arrangements, enhances social credibility, connect you to friends, boost confidence,	Less affected by others if they were properly informed about system, somewhat effected by what people thing	/	Email functionalities, manual, should not breakdown a lot, speed must be controllable, customizable, interactive recommendations, provide useful information, good grip on walker, accessible breaking system, aware when user is not connected to it, good lighting	Needs to be have good handlebar and grip to be operated well	Support her to do more music, support and suggest good eating/dining recommendations	P-Muscles weaken P-Costs P-Audio sensitive/noise sensitive P-Lack of confidence P- Fear P- Legibility of signs is a problem	
160816_002	Isabel	Accepting of the system, feel worthy	Expects it to have good design, grip, seating etc. Help with getting out, help with getting around, navigational aid	social credibility, unlikely to be influenced by others opinion	Likely to be influenced by people's positive opinion	Walker might be dangerous to drive because of children and other dangers, helps to have someone to guide her until she's used to it, computers can be illogical	Should be easy to operate, instructions should be understandable	Women socialize better than men, likely to use if referenced by a friend, eating arrangements, scrabble, has expertise as nurse and would like to use them, likes to walk	P-Difficult to meet new people, P- immobility,E- going uphill is a challenge, impatient,P- lack of acknowledgement for volunteering efforts	
	Michael	Accepted	/	/	/	Computers don't behave as expected , needs to operate in different weather, motivation to use can be low, needs to be available when needed	Confident but operating technology can be frustrating	/	P-Family duties to take care of grand children, P-loss of will, P-costs,P- hip problem, P-lack of confidence to do what he loves, P-degenerating health	
160816_003	Tom	Gives him confidence , feeling useful, apprehensive about depending too much on system	Expand his horizons and meet new people, assist people	Influenced by the general need for older people to be more social, careful about hurting others with system	Likely to be positively influenced by system usage by other users	Prior experience with ipad and computers helps, need to have wifi, could be apprehensive about breaking computer, able to use their hands, other people with the system willing to assist, must be of compact and transportable dimensions	Likely to be frustrated using a computer, afraid to make mistakes	Volunteers at charity shop, sketching by the river, meets new friends at art class, church, pilates,	P-Became ill, P-prostate cancer, P-falls often, P- very proud (vanity),	
	David	Boost social life, build confidence when when going around, boost confidence	Get them out of the house	Likely to be influenced by someone she likes, be embarrassed of strangers or people she does not know well	Competitive, likely to be influenced by other users	Do short trips to get her familiar with use, use it in familiar area, being educated about the system	Confident, always stays the course	Has good computer skills, good linguistic skills, organizes activities for her Italian language group, Italian cultural events, teacher	P-Had a hip replacement causing her to take longer to recover,P- needs someone to persuade her to go out, P-frequent weakness in her legs, P- Alzheimers, P- dementia	
160817_001	Isabel	Pleasantly surprised , fulfilled, addressing a sense of missing out,	Keeping active, planning your day	Influenced by daughter	Likely to use it if there was a social consensus	Computers are a challenge, prior bad	No confident at all	Skills such as cooking, knitting, quilting,	P-Used to being P-housebound, P- fear of talking to people	

		great if introduced early enough in life				experiences with sales people		technological introduction through grandkids		
	George	Feeling relaxed, more connected	Communicate with new friends, share useful information	Likely to be influenced by others who have strong positive opinions about it	Likely to use due to positive reviews	Some people have a fear of using technology, technology must not be prone to breakdowns	Challenging to use a computer for the first time	has particular/unique historical background	E- Loud city noise	
	Tom	Feeling relaxed, more connected	Connect with people with same mobility challenges	Likely to be influenced by people in the same area, otherwise not affected by other people	Likely use it if others were using it	System needs to have reliable, up-to-date information, no inaccurate information, technology knowledge sometime not transferable from a particular generation, younger generation more likely to excel at using new tech, inaccurate matches from system since it's definition of compatible matches might lack human insight	System should be simple to use	Meets with work group, part of walking group	P-Widowed, P- not enough time, P-social isolation, P-some people can be technology resistant, P- stuck on old technology, P- mobility issues	
160817_002	Tom	Nervous at first, later would be happy using it	Meet new people with similar interests	Likely to be influenced by a negative and positive reviews of the system	Wouldn't have much effect	Step by step instructions, personal assistance from support staff, introduction, good success with the people the system had suggested, complete information, if it is complicated and didn't recommend interesting people	Somewhat confident	Law, sports, football and disability interests, chance to learn about law of other countries, acting, volunteers	P- Can be challenging to meet new people P-Living alone	
	George	Initially apprehensive but grateful later on	Meeting new people,	Likely to be influenced by negative and positive reviews of system	/	Recommendation to use system prior to use	Somewhat confident	Meeting with people with similar interests face-to-face	P – Meeting new people	
160817_003	Anthony	Feels good, improvement in social life	Would like to meet new people	Hopes other would use it, General Practitioner, work friends, Daughter	Likely to use it as a point of conversation with other people, neighbors, friends	Straight-forward, clear information from the system, must not be too demanding in a physical sense, shouldn't be annoying (nuisance)	Likes usable systems, confident and not afraid of computers, prior knowledge from teaching IT, adds that tech changes	Like music as a hobby, DIY gardening	P- Does not get to meet new people often	
	Michael	Excited to try	Would feel enabled, use friwalk to sit and rest, confidence boost, get out and about	Daughter, husband, son-in-law is trained paramedic, not embarrassed to use assistive tech	Would be encouraged if others were using it	Should not require too much concentration, not strenuous, Friwalk locations should be easily accessible,	Confident when there is moral support, confident that they can manage to use the system	/	P-History of stress headaches, physical mobility, P-Assistance get to and from places	

						should be usable in beach terrain, open air activities, would use with enough moral support, needs encouragement, female company, needs to have breaks, must be of transportable dimensions				
160817_004	Anthony	Would feel like he is benefiting	Would benefit from getting out of the house, become more active, be connected with people who were also in the ex-service	Fellow ex-service men, friend's sister in law	Likely to try it if other people were using it	Highlight aspect of meeting people and getting out, frightened of technology, doesn't like computers	Very resistant to going out and trying technology	Was in the ex-organisation, has unique set of skills	Sedentary due to hip replacement, frightened of technology	
	Sarah	Feeling included, not lonely	More enjoyable social life	Husband or partner	Likely to use it if other people used it	Should connect married couples, would rather the system was presented by an older adult, should have features for couples, meet with other people in their area, encourage people with their own transport, bad weather could effect adoption, video calling	Happy to use technology, confident	Married couples that like to do activities together	Trouble getting to places, no transport, public transport is difficult to obtain at night leaves in the country and it is hard to meet people, fear of falling, risk of dying at any time	
	Tom	Happy, enabled to recruit more volunteers	Use it to encourage older people to be more active, to get them to volunteer, use to recruit older adult involvement, meeting new people	Would be largely unaffected	Would enhance his existing enthusiasm to use the system	System matching functions should be localized, not having a car would make it hard	Very important that it is easy to use because people are afraid of technology	/	Difficult to recruit older adults to be active and social	
160819_001	Fatima	Gives her confidence, sense of security	Help her with mobility, boost confidence	Friends and daughter	likely to use it if she saw someone else using it	Should be light and transportable, having a seat for resting not for being pushed around, someone to explain system advantages, should have sensors, needs reassure her in her mobility, should not be big and heavy, aluminium	Very independent, needs to be easy to use	Very independent, loves Shotton	Inactive, does not have strength to operate heavier aids, no mobility	
	Tom	Would enable him to helps others, satisfaction, self-achievement	Expects to be matched with people he has things in common with, meeting people, invite friends	Wife	Likely to use it if others used it, voluntary organisations	Make him feel useful and needed. Initial use might be challenging	Important for it to be easy to use	Wants to help people, provide transport, likes museums, would like to organize a trip for friends	Limited in walking long distance	

	George	Gives her confidence, sense of security	Give her mobility and enrich her life, make her more active	Daughter	Not influences by others, judges by whether it suits her requirements	Needs time to get used to system, transport is a challenge, system needs to be transportable, might feel like system should be for younger people	Confident and likes to try new things, shouldn't be complicated, has experience with tablet and laptop	Member of a club for stroke sufferers, part of religious groups	Lack of confidence to do activities	
	Sarah	/	/	/	/	Need to be displayed at Metrocenter being successfully used by other people, shoe relevant information, age appropriate info, communicating aspect is good	/	Adventurous but limited by mobility, likes Traveling	Growing less active due to age, restricted by health	
160819_002	Manuel	Boosted confidence, mobility	Good mobility, support good posture	Using a stick has stigma, none the less would use assistive tech if it was useful, Healthcare official, doctor, physiotherapist	Influenced by the criticism of others using assistive devices	Needs to be transportable, needs to fold up, light, able to carry a pet, prior knowledge of the system is important, be able to help with groceries, would like to have private ownership of system, function in different weather (cold, hot), needs to be safe to use, needs to be light, adjustable handlebars	Needs to be easy to use, needs to support good posture	Samba classes, cinema, shopping, owning a dog, likes scooters	Persistent fear of falling again, lack of confidence to do activities,E- hot or cold weather conditions, E-walking up a flight of stairs, no car and public transport is not always reliable	Needs to be light enough to carry, fold-up
	George	Wary of dependence on tech	Learn about interesting events that are available	Not easily influenced	Not easily influenced	Recommendations about what's happening in the area, should know user interests, tailored to user personality, shouldn't break-down a lot, filter for relevant content	Needs to be easy to use	Likes acting, involved in charity, Third age older adult group, loves dogs, small pets and animals, theatre for children	P-transportation, public transport is not good, charity, P-has too many activities, does a lot, spends a lot of time standing	Make once of recommendations and that don't require continuous commitment, need different versions of the system, basic and advanced version, able to go up steps, be affordablee
	Jose	/	/	GPs recommendation	/	Technology should record exercises	/	Goes to the gym for aerobics	P-Costs, P-Fear of another fall, P-doesn't have good balance, P_Asthma	Should be able to have FriwAlk and Fritab at home, Fritab must be complemented with a Friwalk to enable user to be social
160822_001	George	Happy,	Use it to get up and about, meet new people	Daughter	Would use it friends were using it	Should be accompanied to group meetings, connect her to people in same situation, system should be non responsive and should be easy to troubleshoot	Must be easy to use	Goes to church frequently, religious, good at mixing with people, confident if properly guided to use system	P-Lack of confidence, P-Lonely, P-problems learning new things	Should be accompanied to group meetings by someone they know, recommend things to do with a partner

	Manuel	Happy, confident	Join different groups of people, have conversations with different people, meet people to get her out, meet other people in the same situation	Not influenced by any particular person, doesn't want be seen using a walker	Would be encouraged to use it if other people used it	Has a husband who doesn't care much for being active, system should not have faults, likely to use it if it could arrange care for her husband, should be easy for her to get in touch with a social worker	Should be easy to use and not complicated	Physically able, has many interests, gardens and flowers, meals and dining	P-Has to take care of her husband P-Already has a very busy social life	Ability to arrange and plan care for her husband
	Isabel	Pleased to be doing what they like with other people	Expect to meet people in the same situation as her, improve mental and physical health, help her lose weight	Daughter, people she interacts with on the system	/	A bad experience with someone she met through the system would put her off it, reassurance will motivate her	Needs to be easy to use	Likes to go walking, visit television studios	P-Lonely, doesn't have anyone to walk with, P-homebound, P-weight gain, P-Widowed	People should get Fritab invitations through the telephone or mail
160822_002	Michael	Feel liberated	Not remain isolated and meet with people, get more interests, get more knowledge	Other users of the system		Should have a seat, a convenient mode of transport, would use system because of curiosity, needs to easily accessible, doesn't want to be dictated by system	Very very important that it is easy to use	Is computer literate	P-mobility problems, E- trouble getting to places of interest, P-difficulty walking, P-Knee and hip problems	Walker should have a seat, provide free transportation for older adults, system should suggest a convenient mode of transport for departure and return
	Tom	Happy to be connected with people with same interests, feeling fulfilled because of helping others	Use to explore subjects of interest, invite friends to outings, would like to meet more people with same interests, satisfaction of helping others	Not influenced by others by her own motivations	Would be encouraging if other people where using it	Easy access, clarity of information would encourage use, c	/	Retired and looking for activities, volunteers for age UK, mentors young pupils, attends UA3 meetings, art club, gardening, walking section	P-Retired and needs activities to do	/
	Anthony	Wanted, useful, accepted	Put user in touch with other people with similar problems, get Anthony out of the house, get a wider spectrum of interests, make friends	Friends, other users of the system	Likely to use it if others used it	Should recommend public meeting places for people, connect people with similar work background, needs to be easy to use, tuition, peer help, would be afraid to use the system because of lack of knowledge, fear of technology, might not want to enter personal details	/	Likes shopping, likes photography	P-Widowed	/
	Isabella	Happier, more socially included, less isolated	Meet up with people of similar age and interests	Friends she likes	Likely to use it if other people used it	System needs to be able to vet users, have a star rating system, ease of access, lack of motivation and no knowledge of how to use system would put the person of it this can be overcome by showing person how	/	Gardening	P-Mobility challenges, socially isolated	Needs to make sure people are vetted and that users can meet in safe places, people can endorse each other after meetings, have a rating system

						to use the system, lack of response would make it hard to use system				
160823_001	Isabella	Apprehensive, especially about walker driving automatically	Use it to navigate exhibitions in the museum	Son, would feel slightly embarrassed pushing a walker	Not influenced by other people	Screen should be well lit, showed a museum map with information about exhibitions	Should be very easy to use	Walks around	P-Eyesight problems, challenging to read P-Hard time finding things in the stores P-Poor memory	Should be able to remind you where everything is in a store because shops change their layout
	George	Cheerful	Recommend chess group events, find partners to play with	Friend that he plays bridge with, his best man	Would slightly influenced by other people using the system	Would use system if he had more free time	Needs be easy to use	Playing Bridge and chess	P-Cares for wife so doesn't have much free time	Allow people from groups on the system to call other members and invite them to join
160824_001	Manuel	/	Get information on where to meet people	/	/	Encourage visits from family, way of recording information about a fall, alert for one some falls, meetings should be welcoming, recommendations should be matched to people	/	Good attitude towards staying active, is part of various groups, part of a writers group, U3A, knitting	P-struggles with technology P-Lack of confidence P-Fears falling and breaking their arm P-Socially isolated P-Not easy for old people to get socially involved	Record information about a fall to find out cause
	Manuela	Enabled, less isolated	/	System expert that gives all the relevant details	/	Feeling welcomed, get support system around the system, someone to help you on the initial use of the system, sense of need, needs to be very very easy	/	Has good friendships, often goes out in a group	P-Macula degeneration P-Anxiety of being visually impaired P-Lack of confidence	Great that people expect her where she is going, someone to guide you through using the system in different use cases during the initial phase, Have a Braille base access function, Audio based interface system
	George	Feel nice to have information she wants	Like to find out what going on in their area, find new areas to go to	System expert	/	Easy access, explanations for technical terminology or easier language	Should be easy to operate	In an acting group at U3A, quiz group in U3A, in a writers group, very creative, does embroidery, curiosity for something new, independent	P-fear of technology	Helps if people you are meeting up with are expecting you, especially for groups you've joined
	Tom	Feel empowered	Meet people with the same interests, Easily plan get-togethers	/	Happier to use it if other people used it	Able to invite others to join activities, allow her to give out useful information, Give her useful information	Needs to be easy to use	Loves organizing things, planning get-togethers, visiting Laing Art gallery, theatre and performing arts, cinema, bus trips	/	/
160825_001	George	Indifferent	Receive tailored information based on their interests, expects system to allow him to contribute something, learn new things	Not influenced but would consider the advise of a doctor or nurse	Would use it if friends and family were using it	Must show up-to-date information, clear information on where to get help, way of vetting users of the system, make it easy to relate to the technology as most users would be unfamiliar with smart	Confident with technology use, needs to be easy for old people to understand	Interested in grand children, Comfortable living alone, likes money and playing computer games, frequently goes to local leisure center, Voice North, would like to help people with computer	P-Has issues using new technology P-Widowed P-Grown to like being alone and doesn't want to change it	Usability of technology is generation specific, introduce to people early when they are about to retire, phone support

						phone technologies, information about system should be widely available, motivated by curiosity, needs to have an easy to read guide (idiot's guide), language needs to be understandable		problems, part of the ex-forces, likes Wikipedia		
	Sarah	Altruistic	Meet people with stimulating interests, interested in contributing to a cause	Not influenced by anyone	No difference	System needs to target what she is interested in, give, personal guide to the system, someone to answer her questions, easy to follow guide, screen well lit, legible and easy to understand	Likes to do things herself	Gardens, lives in a rural area where there isn't much to do, likes to go out for a drink, involved in a charity, likes to volunteer	P-Medical challenges P-Color blind P-Hard of hearing	System should be introduced by someone the user knows, trusts
	Anthony	/	Find activities within their own community	/	/	Show relevant details about learning programmes, connect old people with young people to share knowledge	/	Goes to a man's club, likes computing	/	Allow the system to match people with the same illnesses, interests and hobbies. Show information about learning programmes, mix old people with young people
160826_002	Isabella	Appreciative, enabled	Give directions to lifts and other shopping information	Doesn't want people to know her health issues	Likely to use it if other people used it	Should be able to avoid collisions with pedestrians , Fritab with hearing functionality, demonstrations, audio interface, wouldn't like the feeling of being watched all the time, needs to be safe	Not confident using IT	Independent, likes audiobooks	P-Hearing problems P-Fear of going around in he big city, traffic	Link systems with an earphone output, personal security
	Jose	Confident	Encouragement to do more walking, connect with other people in similar situations, more social interactions	Professionals at the hospital (medics, doctors)	/	Let user know where public toilets are, have updated information, give reliable directions, show the weather for trip plans, have a crash course, audio interaface	/	Has lots of knowledge	/	Ability to take Friwalk on loan, ability to attach Fritab to different supportive aid
	Anthony	Happy and capable, Empowered	Meet people with similar interests, Show certain sections in shopping mall, doctors	Family, Son	Likely to use it if other people used it	Needs to be simple, target people who are IT literate, help with getting over the initial fear of computers, info sessions in the sheltered home, audio and visual instructions, have support staff, Needs to be easy to use, not	Not confident in using IT	Going to the cinema	P-has dementia P-Scared of going to unknown places P-Has mobility problems P-Has eyesight problem	Have supporting staff to walk user through system use, Invite a friend along to help use the system for people with poor eyesight

						present tto much information only simple basic ideas, Has to be portable, needs to be easy to use				
160831_001	Isabella	Feel capable	Would like to get out of the house, meeting people, gain her independence	Close friends	/	Should be able to carry shopping items, accessible, needs to be easy to use	Art gallery, theatre, very in-the-know and confident	Volunteers with RNIB, organizes groups sessions for people with eye-sight problems	P-Problems with her sight P-Costs	Concerns about changing from assistive mobility devices
	Tom	Boosted confidence	Connect with other people in the area going through recuperation for a hip replacement	/	Likely to use it if others were using it	Needs to be easy to use	./	/	P-Has to care for spouse P-Spouse's condition limits activities they can do together	Could be suitable for recuperative health
	Anthony	/	/	/	/	/	/	Knows a lot of people	P-Mobility challenge stops her from meeting people P-Challenges walking for long	/
160901_001	Dorothy	Feels a sense of independence	Increase her confidence, be matched with other women with similar interests, connect with people she used to work with, improve her social life	Close friends, Neighbors	/	Highlight the feature of support and building confidence, lesson in using the technology, needs to be very simple, walker needs to be adjustable, foldable and transportable	/	Starting to get more physical active, attends church, women's guild, embroidery	P-lock of confidence to go out after fall E-Easy to slip and fall in the winter P-Challenge getting to the bus stop P-Doesn't have a bank account	Should help with arranging transport
	Anthony	Involved	Match with people he used to work with	People that he helps, neighbors, close friend	Likely to use it if other people were using the system	Potential use cases of system should be demonstrated, needs to be easy to use, shouldn't be intrusive, not offer too many choices	Determined	Goes to the pub, has a reliable friend, helps neighbors to set things up, local history, walking groups, geology	P-Doesn't do enough walking	/
	Tom	/	Meet a variety of good people	Wife	Likely to use it if other people he knows used it	Offer once-off projects people can participate in, option to disable requests from other people	Confident, familiar with technology, flexible	Wood carving, video making, volunteering	P-socially active but doesn't get enough physical exercise	Offer once-off projects people can participate in, recommend elder married couple activities
160902_001	George	Initially apprehensive about the system	Use it to find out what others are doing	/	/	Would need to get used to it, getting a negative experience from people would turn him off it, needs to be a bit challenging, needs a bit of a push to start using system, encouragement, fear of damaging the system	Needs to be easy to use, like a telephone	Likes learning, attended night classes, likes non-English cooking, bowling, badminton, archery, gardening	P-costs	/
	Fatima	Very wary of the system	Use it to send alerts to their doctor, reporting improvement to	Worries about what people think about her, thinks supportive aid encourages	Would consider it if other people had positive opinion	/	/	Has a good attitude to keep walking but	P-Doesn't walk properly P-Trouble finding things in the shopping center	Be able to point out certain items in the shopping mall

			doctor, help user walk properly, use it to get to shopping center and hospital	stigma, Respects doctor's opinion				doesn't want to use an aid		
	Manuel	Feels like he's benefitting	Show him he is improving improvements, encourages him, offer useful advise, help him get out more	Daughter	/	Encouragement would help, help her get out more, would turn down system because of pride	/	Likes to be capable, doesn't like assistive supports like sticks, very determined, like to be independent	/	/
	Sarah	Would feel enabled to learn new things	Meet new people, find out about event	Husband	/	Help with learning new things, would need time to used to it	Needs to be easy to use	Needlework, patchwork, reading, has some friends, works in a charity shop, experienced using an ipad	P-Lives in a rural area, knows few people	Should be affordable

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ID Participant	Scenario	Experiential attitude (Q3a_Q4)	Instrumental attitude (Q3b_Q4)	Injunctive norm (Q3c_Q4)	Descriptive norm (Q3d_Q4)	Perceived control (Q3ef_Q4)	Self-efficacy (Q3g_Q4)	Facilitators/Opportunities (Q2)	Personal barriers/problems regarding everyday life	Other barriers	Suggestions for improvement
160815_001	**Fatima***	She'll feel used to using it if she uses it regularly: "like having a pair of gloves on. She can't go out without her gloves so she can't go out without that."	She could get better posture	It depends on the person whether this has an effect.	If she saw other people using it, she would wonder if it helps	Barriers to use: Getting to the shopping centre. Navigating the shopping centre. Reaching shelves. Cost of walker.	Fear of falling could stop her using it. If it's similar to her existing walker she might use it.	She could find friends at local church groups, women's guild, neighbours. She enjoys shopping. She could meet friends for lunch.			Quiet to use. No rattles or bumps.
160815_002	**Tom***	A sense of satisfaction over doing activities with different people. It would make user feel more in control of things. Feel worthwhile being part of a group, meeting new people and expanding his network. / But if person is afraid of technology they might not want to use it.	User may be able to use the device to contact someone in an emergency. / If the system doesn't work well at first, then they might stop using it. / If it pairs you with a boring or senile person you might not use it.	Prompts from other people (e.g. a message via the system) would encourage him to use the system. But it depends on the person as to how much encouragement they need.	If other people use it, it will encourage them to use it	If someone is retired they might have time available to explore new activities sometimes. / If the system is not reliable, the user will stop using it.	Ease of use is important. Simple buttons rather than extensive menus is necessary.	He might want to find people with similar interests	None		Age limit on the system so that people of similar ages meet. People on the system should be vetted.
	Michael*	It would make him feel good and more socially involved to use the system.	He would want to get out of the house to do things. He would get exercise, fresh air and social involvement.		Because there would be other people with similar issues at the museum, he would not feel out of place using the system.	Getting from the house to the museum is a problem. And if the walker was badly designed (ergonomically), it might stop him from using it	Should be as easy as possible to use.	The user could discuss his health condition/problems with a similar other	The character can't walk very well or far		The destination could use a minbus to collect people who want to attend an event. Make sure the device has a seat so that the person can sit down.

160815_003	**Isabella**	She might find the system a bit "nannying" if it steered her. It might maker her feel helped - but people resisted feeling helped because they want to be independent. It might make her feel embarassed to use it. But it could make you feel more confident. Using the bracelets would make her feel very pleased.	It would help her friend find shops. Audible instructions from the machine would be embarrassing. It would take her to where she wanted to be.		It could be more encouraging if it was more commonplace for people to use the system	It wouldn't tell her when it was safe to cross the road (getting there).	Her attitude of mind will affect whether she wants to use it - she needs to see the benefits. It needs to be easy to use because it is easy to make mistakes with computers.	She likes talks, meals and slideshows - but can't see the slides anymore.	Friend has eyesight problems and has to listen for traffic crossing signals. She finds railway stations a problem but she gets personal assistance from staff. She has a very bad knee.		User would prefer haptic bracelets because these avoid the stigma of having audible instructions being given.
	Dorothy	Using it would make her feel happier; more confident. / She wouldn't like to be directed by the FriWalk yet.	It could help her go anywhere she wants. / But if she knows where she is going, she doesn't need it. And if she has her own walker, she doesn't need one. / But if she uses a stick (the participant does), then she would find it easier to use the FriWalk. It would also provide a space for shopping.	If she needed it, it wouldn't matter what other people said about using it	She would like to feel "part of a club" of users. She has previously said to people "your walker is similar to mine"	User interaction would have to be easy	It would need to be not too complicated	If the system provides confidence, she can go anywhere she wants.	Fear of falling. Loss of confidence.		Sometimes you don't want directions; you just want to browse the shops. / Walker should be slim enough to avoid catching edges of shop stands. / It could provide information about places to eat and recommendations from friends.
160816_001	**Dorothy**	She feels excited about the prospect of the system. She "loves" the reminder bit (when she has been inside for too long). She "loves" the idea of the system and wants to try it. She loves the idea of getting bus times. / She wouldn't find it stigmatising because "it's got serious street cred"	It would make finding places like the bus station in the shopping centre so much easier (they keep changing its name). It would also encourage her to get out more if she has been staying inside too much. / When she is out, she needs to know where she can rest.		People would be impressed to see how much the system transformed her abilities. She would also enjoy seeing other people using it and would want to stop to talk to them.	She would definitely use it if someone told her where to get it. / She would feel very anxious if it started behaving strangely and she didn't know how to sort it out. / It should come with a handbook to help her work it. / If it broke down a lot, she wouldn't want to use it. If it made silly noises, she wouldn't want to use it.	The simpler it is, the more likely she is to use it.	She loves browsing guitar shops.	Sometimes she lacks motivation to go out and she needs encouragement. She also likes to know where she can rest if she is out.		She needs to go to the toilet every few hours so needs to know that a toilet is nearby. / It could provide consistent naming of things like the bus station (as opposed to having it change to "transit centre" for example). / She would like it to tell her when to rest because sometimes she over-exerts herself and it might be able to pace her. / It would be good if it could move a bit by itself to help with walking.
	Isabella	Connecting her with someone else to go to the shops with would give her confidence. / If it made her feel confident, she	If it moves her out of the way of obstacles, it would be good. She likes the idea of being connected to someone with good	The system would need to be supportive and encouraging in its recommendations		It would need to be ergonomically designed - i.e. handgrips. It would need to stop if she seized up. / If it broke down lots she	It would need to be able to speak to her.	She likes music shops, tasting sessions	Bad eyesight, reading labels in shops, loss of confidence in going out		It could tell her where to find the things on her shopping list. It should have a panic button if the user is in distress.

		would use it. / It would feel like a friend.	eyesight who could help her around.			wouldn't use it. Breaking down would make her feel stranded.					
160816_002	**Isabel**	Some people don't like change. Using a system like this might make you feel "worthy" because it has "street cred" and you can explain it to younger people.	Getting out of the house.	People she trusted would shape her willingness to use the system. If they said it was no good she wouldn't use it.	If others were using it, and recommending it, she would probably have used it.	82 year olds are unlikely to use email. / A third party to introduce people would be helpful to overcome hesitancy. / Cost of the system would be a barrier. / Weather would be a barrier. / Free bus pass would be a facilitator.	It's easy to get put off if something isn't simple.	She was interested in Scrabble. As a nurse, she used to help her diabetic neighbour.	Friend found mobility difficult - especially walking uphill. She needed to rest frequently. Needed to locate toilets.	Lack of personal motivation to use the system because she felt old.	Someone should introduce them first - or even a phone call. Otherwise they are unlikely to meet.
	Michael	He wouldn't use the system at the moment because his hip is too painful. But prior to this he might have used it.				His primary interest is in selling his plants at the car boot sale. But the system couldn't help him with this.		He loves gardening. He used to do a car boot sale with his plants. He still grows plants but can't go to the car boot sale anymore to sell them.	Her friend was pretty active but is waiting for a hip replacement.	He avoids going out because of his hip.	
160816_003	**Tom**	It would give confidence. Men feel useless after they give up work and this would make him feel useful.	Expanded social horizons			She isn't sure that the museum is free anymore. / Wifi at home.	Fear of using computers might prevent him. Fear of breaking it. People who don't use computers can get easily frustrated if it doesn't do what they want.	Still room to make more friends. He volunteers at a charity shop. Attended an art class.	(Friend) A lot of his friends have died. The older you are, the harder it is to make new friends.		Peer-support in using the system and figuring it out.
	David	Could provide confidence. When she gets bored sitting in the house, she might decide to use it. She might be embarrassed to use it sometimes (in polite company)		She has friends who encourage her to get out.	Other people using it would help her. She's quite competitive.	She would need to find out about it from somewhere.	If she saw an advantage to using it, she would overcome any obstacles and would stick at it.	She likes going to a shopping centre at the MetroCentre because she can park outside. She enjoyed teaching a language class; visiting Italian restaurants; speaking Italian.	Friend frequently falls at home. She has had numerous hip operations. She gets tired easily when she is out.	Too afraid of going out at the minute for fear of damaging her knee	The system should recommend activities in line with the confidence levels of the user
160817_001	**George**	A sense of achievement, a more fulfilling life. A bad experience would make him stop using it	The desire to get out more would motivate him.	Other peoples' impressions of the system will affect his willingness to use it. The system needs people who enthusiastically recommend it.	Other people would be influential as long as their feedback was positive. Also, if others are using it, non-users will feel like they are missing out.	It would only work if the recommendations were suitable. If the technology breaks or is not reliable, people will not use it.	If you show people the benefit, they will invest in learning the technology. But getting older people to use technology for the first time will be difficult	He likes reminiscing. He is a Dundee United fan.	People aren't aware of what is happening locally. He might be missing out on meeting new people.		Maybe contacting people by videolink would be helpful in making initial contact. Recommendations should be adjusted for preferences (e.g. don't drink alcohol). / The system should push (actively provide information) rather than pull (wait for people to come looking for it). The system could list success stories for other people to read.

	Tom	It would make him feel more connected if he used it in the future. But a frustrating experience would stop him using the system	If he was going to use it in the future, he would use it to find out about things in the local area. It would stop him missing out on things	No effect on him	More people using it means more opportunities	Doesn't have enough time to use it. If he used it: everything in the system would have to be up to date and accurate.		He enjoys theatre visits. People need someone to go to the theatre with.	No problems because he already has a wide social network of friends. Thus, no motivation to use it at this point.	Inaccurate data.	
	Isabel	Boredom at being in the house all day may have motivated her to use the system. She might have enjoyed the technology if it was simple enough. A bad experience would stop her using it.	It might have kept her active longer if she used it.	If there is consensus agreement that it's a good thing to use, she would have used it.		You're wary of meeting new people. The system might match you with someone that you're not compatible with.	She might not overcome the technology hurdle. She probably wouldn't have used it because she wouldn't have understood the technology.	His friend enjoyed cooking, cleaning, quilting, needlework. She enjoyed reminiscing.	Mobility.	Eventually people reach a point where they can't be motivated to go out more. People don't have time to invest in learning difficult things when they are old.	Allow people to meet as a group and then choose who they like as a friend.
160817_002	**Tom**	He would feel nervous using it at first	The chance to meet new people would be an attraction		If other people reported bad experiences, he wouldn't use it and vice versa.	The system might inundate him with recommendations based on the slimmest similarities, which would be annoying. If he had to pay for it he might not use it.	He would need step by step instructions on how to use it - instructions and someone he could phone up.	Participant enjoys volunteering. Enjoys helping with legal advocacy for people with disabilities. He's interested in sport.	He would like to meet new people	If he had previous bad experiences in using it, he wouldn't use it	
	George	Initially, he would feel apprehensive about using the system but would get familiar with it.	He would use the system on a day when he felt that he needed more social contact			He would want advance notice of the age range of the group before he went along. If it didn't show him things or people that he would be interested in, he wouldn't use it.	He wouldn't use it if it was very complicated to use.	Participant enjoys volunteering. Enjoys helping with legal advocacy for people with disabilities. He's interested in sport.			
160817_003	**Anthony**	It would help him develop an aim in life	His main motivation would be to find a contact with shared interests	His daughter might influence him to use it.		The system might become a nuisance and make more demands of him than he wanted. Too frequent contact would be bad.	It would need to be straightforward and easy to use	He enjoys DIY, gardening, and reminiscing about places he has been (travel). He used to enjoy playing the piano but can't stretch the notes. He sometimes attends classical concerts. He used to play lacrosse	Participant slightly feels that he should meet more people		
	Michael	It might boost his self-confidence	The seat to sit down and the FriWalk to provide support would be motivators. It would give him the opportunity to get out and about.	He would need someone to encourage him to use the FriWalk. He trusts his son in law and appreciates his company because he is a paramedic.	Other people using it would be an added encouragement. Too many might take too much space!	Getting to the museum would be a problem	He has stress headaches so using the system might require too much concentration. But he feels that he would be able to manage the technology.	He enjoys going to the theatre			

160817_004	**Anthony**	Once he started using it he would see a lot of benefit from it. / The technology might frighten him a bit. / He would be initially wary.	It would get him out of the house (motivator). He would become more active.	His daughter lives away so doesn't have much influence on him. The participant's sister in law influences him (she gets his shopping and lives nearby).		The technology would need to be simple and easy to use	He doesn't like computers	He's a very social person. He would enjoy meeting other ex-service men.	Friend has a hip problem. He doesn't get out much. He won't do his exercises.		
	Tom	He would enjoy recruiting new people. The technology wouldn't bother him.	He could get more people to come to the Older Peoples Assembly or the ex-servicemen's mess. He would meet new people.		The more people using it, the more chance of meeting someone you would like to meet.	The recommendations would have to be for the local area. And if he didn't have a car, it could make it difficult.	It would need to be easy to use		He would like to get more people to come the the Gateshead Older Peoples Assembly or the ex-servicemen's mess.		
	Sarah	It would make them feel that they aren't alone in the world. / But fear of falling might prevent him to go out.	They would gain a more enjoyable social life	You have to be careful who presents the system to them - a 20 year old wouldn't work.	If other people were using it, it would make them look forward to using it.	Local recommendations would be ideal. / The weather could make it hard.	Fear of falling makes him afraid to go out. / But they would be fairly confident in using the system.	They have free bus passes. If they knew something was on in town, they would come.	Thinking of a couple he knows: The community is very rural	She would want to take her husband with her	
160819_001	**George**	It would make her feel more confident, it would give her security	It would "enrich her life". It might make her more active.	Her daughter would influence her. / She might feel it was for a younger person.	She's quite independent in her decisions.	Transport is difficult for her but getting on and off is made easier by her lightweight walker.	If it wasn't too complicated it would be ok.	She's very active, very religious.	His friend: She already needs a zimmer frame to get around. She had a stroke		
	Fatima	A walker is better than a wheelchair because the user is at the same level as other people.	She might be more active. It would tell her about more activities in the loca area.	Her daughter would influence her.	If she saw that it helped other people it would encourage her. If other people were using them at the shopping centre, you would just fit in with the crowd.	It would need to be practical to use - not big and heavy.	It would need to be easy to use. As long as it is explained clearly it would be ok.		Same friend: She holds back a little bit on going out		It should have a seat.
	Tom	He would enjoy helping other people by inviting them to things	He would get to meet people	His wife would influence him to use it.		It would need to be helpful to the people he is inviting. Breaking the ice and making initial contact with people would be hard.	It needs to be easy to use.	He enjoys walking. He couldn't join a walking group but would be ok walking round a museum. He likes museums and galleries.	Thinking about himself.		
	Sarah	Feeling of being "past it"			When people see them at shopping centres, it would encourage them.	If people tried it and it worked, they would be encouraged.	They might say that they are "past that"	Friend is "up for anything". They enjoy travel.	Friend(s) has limited mobility. Not very sociable.		
160819_002	**Manuel**	She likes the idea of the exercises and it "prodding" her to do them. Using the system would give her confidence. She doesn't want the	Despite the stigma, she would use it if she needed it to get around. She would like to "outgrow" the system in her capabilities and thus, stop using the walker.	She likes the idea of the system "prodding" her to do exercises. She would be influenced to use it by healthcare professionals.		It would need to be the correct height (adjustable) to stop people slouching.	The brakes would need to be easy to use. It couldn't be too heavy.	She likes helping at the Tyneside cinema, shopping, walking her dog	Thinking of herself: she lives alone, recently had a fall, nervous about going back to gym after vertigo. She is afraid of falling again.	It isn't as useful if you can't have the FriWalk at home. It's got to be able to cope in icy weather.	

		stigma of walking aids.	But if she had to use it, it would give her mobility.								
	Jose		She might not use the system because she is improving her own abilities to get back to normal. She attends other exercise classes.	She is influenced be her doctor's recommendations		The cost would affect her willingness to use it.		She is quite active	Same as above	It should be at home to help him	
	George	Too many activities make her tired. If a recommendation came up that was like "dangling a carrot" she would leave aside other commitments to do it. She might use it as long as it didn't give her wasteful suggestions and didn't become too onerous.	She is trying to cut back in her life rather than take new activities on. She would be interested in local activity recommendations. She would also be interested in irregular activities (i.e. not on a regular basis).	She doesn't think she's influenced by others		She is restricted by her rural location. Public transport is poor. She is already involved in many activities. Her schedule is already very full. If it breaks down she wouldn't use it.	She is 84 so gets tired easily. She would want the system to be easy and quick to use.	She used to do acting.			
160822_001	**George**	It's a bit hard for someone to go along by themselves to a group. Better if they meet an individual from the group first. / It would give her more confidence.	If she met people in a similar situation (widows), they might be able to help her by giving advice or support. / The system would get her out and about. / It would help her meet new people.	Her daughter might encourage her to use it. But she doesn't pay a lot of attention to her daughter.	Other people using it might encourage her to use it.	Someone would need to explain it to her and show her how to use it. It would be best to have someone beside her to show it.	It would have to be easy to use.	She is a good "mixer" (she makes friends easily)	Her friend doesn't go out sometimes because she doesn't like going home to an empty house (she's a widow).		
	Isabel	She doesn't have much desire to leave her home. But it would improve her confidence.	It would help her mentally, physically, help her lose weight and improve her joints. As long as it got her out and about, it would make her want to use it.	Best means of contacting people to use the system would be more direct (e.g. by phone). She doesn't listen to her friend's advice because she says that she doesn't have lots of friends. The more people she gets in touch with, the more they would encourage her to use it.		If it stopped working and she didn't have anyone to help her, she wouldn't want to use it. If she met up with someone she didn't get on with, she wouldn't want to use it.	It would need to be easy to use. As long as she got reassurance that she could use it, she would use it.	She might like to go walking. She might want to visit her daughter.	Her friend stays at home a lot. Her inactivity is making her gain weight		
	Manuela	It would make her feel quite happy and confident.	She would like to meet other people because she feels isolated. It would help her to meet people who are similar to her. / She wouldn't use the walker part of the system because she doesn't need it.	She wouldn't need to be influenced by anyone	If other people were using it, it would encourage her	If it had faults, she wouldn't want to use it. / She can only follow the recommendation if she can get someone to look after her husband.	She could cope ok because she has an ipad. She also can use skype to contact her son. But if it was too complicated, she wouldn't use it.	She likes gardening, visiting garden centres.	Her friend lives in sheltered accommodation but her husband is very physically unable. She can only go out if someone takes care of him.		

160822_002	**Tom**	It would make him feel fulfilled because he is helping other people. A feeling of satisfaction.	If enough people respond to the recommendation, he would consider it successful. It would be good to get more people involved in U3A and to meet new people.	No one would influence him.	More people using it would be encouraging because it could lead him to find related interests.	Clarity of information is important.	Ease of access is important.	The participant is a tutor at U3A (University of the Third Age). He is retired so has free time. He's always looking for things to fill his days.			
	Michael	Curiosity would provoke him to use it. Using it would make him feel liberated because he can walk where he wants and have a seat.	The FriWalk has a seat but his walker doesn't. It would help him to get transport advice. It would widen his horizons.	Another user would influence him if another user recommended it		He would need to be able to get to the museum. / Knowing that it's there would encourage him.	He is quite computer literate but it would need to be easy to use.		Participant has a knee problem which affects mobility. He uses a walker.	Anklets are too dictatoral if they try to make people slow down.	
	Anthony	It would make his friend feel wanted, useful, accepted. Fear of the technology, fear of the unknown might stop him	It would broaden his horizons. He would gain friends and a wider set of interests.	If other friends who used the system recommended it, he would use it.	Other people using it would be an encouragement.	Tuition and peer help are important.	Ease of use is important.		His friend is a widower.	He might not want to put in his personal details.	
	Isabella	Happier, more socially included, less isolated. She might be afraid of using it but someone showing her how to use it would alleviate that.	It would have helped to alleviate her loneliness. It would have helped her meet likeminded people.	The participant would have recommended it to her	She considered herself slightly superior to others so their non-use of the system wouldn't have affected her	A lack of response from other people would make her not want to use it.	Ease of access is important.	She was interested in gardening	A friend has slightly mobility problems		
160823_001	**Isabella**	It would make him look silly pushing it around. But it wouldn't affect him too much - only slightly.	He would use it if it provided a more logical classification of what was in the museum. If it showed a map with different categories of exhibits, it would be good. / But sometimes he is lazy and if he can get along fine without it, why would he learn how to use it?	No effect	No effect		It's important that it's easy to use.	He likes museums	Some eyesight problems so difficult in reading things. Difficulty in finding things in the shops.		
	George	Using it would make him feel quite cheerful.	The system has done the hard work of finding someone with similar interests.	His friend phones him up and encourages him to get involved in activities.	It would encourage him if other people were using it, but not very much.	Having free time (which he does) would help him use it.	Quite important that it's easy to use	He likes playing bridge and chess but doesn't have many others to play with.	He's lazy and doesn't go along to groups.		
160824_001	**Manuel**	They would be a bit fascinated but it might not make them want to use it.	Both friends had family who looked after them so they weren't socially isolated. They didn't feel any need to get					They enjoyed attending their knitting group	Two friends who fell and had fractures.		

			more involved than they already were.								
	George	She loves the idea of finding out what is going on. / Curiosity about what's going on would motivate her. / She has some fear of technology.	It was good that people were expecting him when he arrived at the group. / Need for something new would motivate her to use it. / It would help her find out what is going on.	She doesn't need people to influence her. The researcher would influence her.	Other people using it would be an encouragement.		Use would depend on how difficult it was to use the FriTab. Terminology about the system would need to be clear because it confuses her.	She's in an acting group, writer's group, quiz group. She does lots of creative work at home like embroidery and oil painting.			
	Tom	It would make her feel empowered.	It's nice to know that people are waiting for you. / The system would help her organise group activities.	Word of mouth suggestions that she use it would encourage her.	It needs to have other people to use it for it to work.	The museums are free and lovely.	Ease of use is very important.	She likes going to the museum, going to the theatre, cinema, day trips			
	Manuela	With eyesight problems she would be frightened and disoriented and she doesn't know if the system could help her. / But if a person helper her while using the system, she would have loved it. It would have made her feel less isolated.	Her need to get around would have motivated her to use it (only with personal assistance).	If it was told it was available and explained how to use it, she would have used it		It could speak to her rather than just visual interface. / The system would need to be regularly updated. / It would need to be very reliable.	It would need to be very easy to use. It would be good if you could clap your hands and it responded - or spoke to it.		Participants has macular degeneration (eyesight problems)	She would need a person to help her rather than a gadget	If the system put her in touch with a person who could help, it would be better
160825_001	**George**	Curiosity would motivate him to use it.	He would be interested in using to see if he could learn anything. He would like to help people. He wouldn't be interested in socialising outside specific activities. He would enjoy giving (helping people) more than receiving from the system.	People trying to influence him would make him suspicious. But friends or family would influence him.		It would need to be kept up to date on the system side. There would need to be somene you could contact if it wasn't working. You would need to have someone to stop bad people getting on the system. An "idiot's guide"/manual would help him use it.	You would need to be computer literate. The language used would need to be simple (non technical)				
	Sarah	Unless the activity is of great interest to you, it wouldn't stick.	To give back what she has taken out of the system	She would need to be introduced to the system by someone she knows or trusts. But she is not influenced very much by other people.	Other people's use wouldn't affect her much	She would have to have someone she could talk to if something went wrong with the system. She would need a manual.	It would need to be simple to use	She needs interests to focus her. She is interested in helping with cancer-related issues (volunteering)	His friend drinks a lot and has had cancer.		
	Anthony		Mining communities already have networks of support. They go to the working man's club and wouldn't need a					The scenario would work if it used hobbies or interests - but not work.			

			system to link them together.								
160826_002	**Anthony**	They would be initially afraid of the technology. Using the FriTab would give a feeling of mastery.	Stressing the benefits of reducing loneliness would encourage people to use it.	Family can be too involved to influence people. Sometimes it requires someone slightly more detached. A session at the sheltered accommodation describing the system might encourage people.	Other people using it would encourage her.	Poor eyesight would require audio instructions. A person to support the use initially would be helpful.	Using it would require the user to be a bit IT literate. It's vital that it's easy to use.		Her friend used to be frightened to go places alone if she didn't know what they were like. She didn't have many interests.	Too much information would confuse people. A few simple hooks would be good to begin with.	
	Isabella	For one friend: Having a walker would disguise the fact of eyesight problems and people don't want to reveal all their problems. But it might reveal other problems so she wouldn't want to use it. She would feel like she was letting herself down to use it. For the friend who would have used it: it would have empowered him to know that he was less likely to fall. He would have looked up instead of looking down.		For the friend who would have used it: a demonstration of how beneficial it was would have helped him. His son might have influenced him.	It might have encouraged him if other people were using it. It would have encouraged him if he was able to show it to his sister as well.	For the friend who would have used it: If he knew it was available at shopping centres it would have encouraged him.	For the friend who would have used it: People who don't get out much tend to focus on the negatives - what might happen. It would need to be easy to use because older people sometimes lack confidence or knowledge of IT.		Her friends had cataracts. One friend could have been encouraged to get out more.		People might have hearing problems as well so headphones might be good.
	Jose	It's sort of "big brother" with the hospital watching you. But it would have increased her confidence.	Using the FriWalk would have been easier than crutches. It would have helped her recover faster.	Health professionals would encourage the use of it. Word of mouth recommendations help.	The system could link you with people who are also recovering from similar conditions.	The system would need to be regularly updated to keep up with changes in places. It would need a starter course on how to use it. Linking audio with it would help. Ability to increase the font size.	Some knowledge of IT systems would be helpful.		When she had a hip replacement, she used to wonder about what exercises she should be doing.	Privacy concerns would affect peoples' willingness to use it.	
160831_001	**Anthony**		In this scenario, the system wouldn't be useful because she knows lots of people. Mobility is her main problem.					She knows a lot of people but her mobility stops her going out. She can get into town but can't walk very far.	Friend lives alone, has health problems, she is a smoker and feels that her health problems are her fault.		
	Isabella	It would make her feel better, more independence.	She might like the walker as a way of getting out of the house and into town.	People like the participant, her friend, would influence her.	Other people using it might encourage her to use it.	Because she can get a taxi into town she can get to the walker easily.	Ease of use would encourage her to use it.	She would like to go to the theatre or art gallery.	As above	Cost, time limit	Having someone with her for the first time would help her get used to the system. It would be better if she could use one FriWalk

											in town rather than changing from one to another based on location.
	Tom	Feelings of embarrassment would have been overcome by the help received from the system.	It would have got her out more. At the minute she wouldn't use it because she doesn't need it - she doesn't have mobility problems and doesn't feel lonely. But during her hip problems, she would like to have met similar people recovering. It would have encouraged her to get out more.		During hip op recovery: others using it would have encouraged her.	It would need to be located near bus stop location. If it didn't work it would have made it hard to use.	Very important that it's easy to use.		It would have been a good system during her recovery from hip surgery.		
160901_001	**Dorothy**	It would help build her confidence	Information about shops sales might encourage her. The system might help her get out faster after her fall.	The prompts from the system would encourage her to go out. Her good friend and neighbour would encourage her to get out more and use the system.		The walker needs to adjust to size and be easy to move.	A lesson in technology would help her use it. She relies on her friend to order things from the internet for her. Very important that it's easy to use.	Her friend is starting to go out more after a fall. Interests in embriodery, women's guild.	Friend had suffered a fall		A trial walker around the house might encourage people to use it.
	Tom		Her friend would enjoy meeting new people and the variety of people. It would help if he could attend activities with other like minded people and not have to bring his wife along.	His wife would influence him to use it.	It would encourage him if he knew of others who had used it.	He might feel that he's not in charge of the recommendations.	He is competent with IT.	Some solitary interests such as wood carving. Used to be a member of a video-making club.			
	Anthony	It might make him feel more involved.	It would give him things to do. He might say he didn't want to use it, but he would try it to see what came up.	The people around him, neighbours for example, might encourage him to use it.	If he heard about other people using it and it was the norm, he might use it.	The recommendations would need to come in quite quickly. But if he had too many choices, he wouldn't like it.		He likes helping people with DIY work. He likes local history.	Friend: He used to have walking problems. Has improved after surgery but needs to walk more. He only has one good friend and has no one when his friend is away.	He needs to have clear ideas of how the system could help him. He tends to start using something but doesn't stick with it.	
160902_001	**Fatima**	He might be wary of the system because people don't like other people to know what's wrong with them.							Friend had a hip operation and has limited mobility. Uses walker. He has Alzeheimer's disease.		
	George	He would be initially wary of meeting new people. Initial	It would help him get a pastime and meet people	His wife would influence him to use it.	It would encourage him if		It would take effort to learn how to use it. It	He's interested in night classes - but they're	For himself: it's hard to know what's going on in the local area.		

		bad experiences can turn you off. / He would be afraid of messing it up.			other people were using it.		would need to be easy to use.	expensive. He's interested in cooking.			
	Manuel	Pride would make people not want to use it - they would feel like they're losing independence.	His wife wouldn't want to use it if she didn't have to use it. But for another friend, she would use it because it would have told her if she was improving or getting worse.	The daughter of his friend would have encouraged her to use it.	It would have encouraged his friend to use it if others were also using it				His wife suffered a fall recently		
	Sarah	At first, she would be wondering if it was the right thing to do and whether it would interest her. If she had a good experience the first time, she would use it again but if not, then she wouldn't.	She would enjoy following new paths and learning new things.	He would influence his wife to use it. Her daughter and a few friends would too.	It would encourage her to use it if others were using it too		She uses his ipad so she can handle the technology. The initial use would be hard - wondering if it's the right thing to do.	She's interested in patchwork, needlework, reading, local history, murder mystery books. She works in a charity shop.	His wife lives slightly out of town.		

Appendix 3: Refined requirements list

Requirements marked in bold have been validated through the current study (interviews with potential users). References are provided, where available, to the pages in this report where the requirements have been discussed. The level of importance has been allocated on a scale of 1-3 based on the level of importance assigned to various issues by the participants and by consideration of how essential the requirements are to support core functionality.

This list of requirements was circulated to project team members who provided feedback on whether the requirements were attainable or appropriate within the limits of the project. This led to some requirements being rejected and these are presented in grey text along with reasoning behind the rejection.

ID	Part of system	Feature	Requirement	Refinement	Interview reference (Page number)	Importance (1= High, 3 = low)	Status
2	Activity database	Data	Be aware of where available FriWalks are located	Activity creators should specify if FriWalks are available for an activity at a particular location		1	
91	**Activity database**	**Data**	**The system should provide information to users about the financial cost (if any) of adopting recommendations**	**Activity creators should specify whether an activity costs money and if so, how much.**	**23**	**1**	
92	**Activity database**	**Data**	**activity recommendations should normally involve pairing older adults but in specific circumstances may link older and younger users. These intergenerational meetings should be clearly identified as such in the recommendation message**	**Creators of activities should label activities based on whether they are suitable for all ages or only for a certain age-range.**	**29**	**1**	
89	**Activity database**	**Data**	**The system should take into account the marital (or relationship) status of users when offering recommendations**	**Creators of activities should specify whether the event is for individuals only or whether people can bring friends/partners**	**22**	**3**	
3	Activity Generator	Data	Matches shops based on similarity to each other (i.e. they sell similar products)	Rejected by developers because this would require database of shops and this is not feasible within the project limits	16	3	Rejected
5	Activity generator	Recommender system	Make recommendations for activities based on stored information about previously enjoyed activities and stated interests	Rejected for reasons specific in req. 3	21	1	Rejected
6	Activity generator	Recommender system	Allow users to accept or reject recommendations			1	
8	**Activity generator**	**Recommender system**	**Provide geographically localised recommendations**		21	1	

ID	Part of system	Feature	Requirement	Refinement	Interview reference (Page number)	Importance (1= High, 3 = low)	Status
10	Activity generator	Recommender system	Recommend fitness-appropriate activities for users			1	Under review
82	**Activity generator**	**Recommender system**	**The system should not bombard users with recommendation prompts.**	**Users should perceive recommendations as timely and may wish to have control over the number they receive.**	**16**	**1**	
7	**Activity generator**	**Recommender system**	**Remember users' previous history of rejects and accepts in order to learn preferences.**		21	2	
9	**Activity generator**	**Recommender system**	**Recommends visits to medical professional based on physical activity/performance decline**	Rejected in this form. The UI may present physical activity/performance data to participants which may prompt them to seek medical advice if they are declining, but the system will not make this judgement.	29	2	Rejected
4	**Activity Generator**	**Recommender system**	**Recommends similar shops to user**		27	3	
11	**Activity generator + FriTab**	**UI**	**Be persuasive in encouraging users to adopt recommendations**	**Be persuasive in encouraging users to adopt recommendations particularly if activity/social levels are low**	**18**	**1**	
13	Activity planner	Data	Medical professionals can provide recommendations to for specific users			1	
12	Activity Planner	Data	Be aware of users' activity plans in order to avoid clashes in recommendations.			2	
14	Activity planner	Information	Display activity-plans of users to specific others depending on privacy profile			1	
15	**Activity planner**	**Planner**	**Use local transport information to schedule transport to activities**		25	1	
16	**CPSN**	**Data**	**Record background information of users (health, interests and occupational history) in order to match users with suggested friends and provide activity recommendations**		35	1	
17	CPSN	Data	Store and disseminate information about public meetings in the local area			1	
18	CPSN	Data	Record attendance of users at public meetings	Notify organisers that a user is intending to come to a public meeting		1	
19	**CPSN**	**General**	**Provides a means to maintain communication with existing friends and family and generate new**		21	1	

ID	Part of system	Feature	Requirement	Refinement	Interview reference (Page number)	Importance (1= High, 3 = low)	Status
			friendships based on location and/or common interests.				
20	**CPSN**	**General**	**Can be used as a means of safe introduction before meeting new people face to face.**		29	1	Under review
21	CPSN	Networking	Allow users to have lists of friends or acquaintances			1	
22	CPSN	Networking	Allow users to create group meetings			1	
23	CPSN	Networking	Allow users to communicate with groups of people with certain interests			1	
24	CPSN	Networking	Allow users to send messages to other users			1	
25	**CPSN**	**Networking**	**Sends some data to medical professional based on privacy profile**		29	1	Under review
84	**CPSN**	**Networking**	**the system should seek to avoid incompatible pairing of people**	**The system should allow users to chat online before meeting up offline in order to avoid incompatibility**	**19**	**1**	
26	**CPSN**	**Networking**	**Includes older and younger users in social network. Younger users should be interested in meeting older people.**		23	2	
30	**CPSN**	**Personalisation features**	**Provide questions about interests and background for initial user setup via FriTab**		21	1	
31	CPSN	Personalisation features	The distance the user is willing to travel for activities	The length of time the user is willing to travel to get to activities	25	1	
94	**CPSN**	**Personalisation features**	**the system should not recommend places for the user to go that their mobility would preclude**		**25**	**1**	**Under review**
99	**CPSN**	**Personalisation features**	**The system should allow users to specify activities or places that they do not want recommendations for**	**This would require a**	**30**	**2**	**Rejected**
27	**CPSN**	**Personalisation features - Data**	**Be aware of mobility problems of users**		25	1	
28	**CPSN**	**Personalisation features - Data**	**Records shop preferences**	Rejected. See req. 3	27	3	Rejected.
29	**CPSN**	**Personalisation features - Networking**	**Link users with similar interests**	**The system should link users with similar interests that they wish to be matched on.**	**17**	**1**	
34	**CPSN**	**Privacy**	**Users should be able to withdraw themselves and their data at any time from the system for any reason**		35	1	
35	**CPSN**	**Privacy**	**Users should be able to specify how much information they reveal and to whom**		35	1	

ID	Part of system	Feature	Requirement	Refinement	Interview reference (Page number)	Importance (1= High, 3 = low)	Status
88	**CPSN**	**Recommender system**	**The system should take the weather into consideration when making recommendations**		**21**	**2**	**Under review**
37	**FriTab**	**Activity evaluator**	**Collect data about user engagement and satisfaction with activities to adapt future recommendations**		21	1	
38	FriTab	Calendar	Contains time for appointments, social events, family and friend dates (e.g. birthdays)			3	
39	**FriTab**	**Communication**	**Email and video-calling should be provided**		29	1	
40	**FriTab**	**Data**	**Be aware of user's location**		27	1	
85	**FriTab**	**Error handling**	**the system should be able to simply explain errors to the user and notify someone who can fix the problem**		**20**	**1**	
41	FriTab	Games	Can be used to enhance attention and memory and for general entertainment			3	
42	**FriTab**	**Information**	**Communicate potential transport information to user**		25	1	
43	**FriTab**	**Information**	**Be able to provide navigation instructions in public spaces**		27	1	
44	FriTab	Information	Be able to guide user back to starting location and home with easy-to-follow instructions			1	
45	FriTab	Information	Display exercise instructions to users with motivational feedback			1	
46	**FriTab**	**Information**	**Display data about number of steps, distance, etc. after each activity and relation to targets**		33	2	
96	**FriTab**	**Information**	**The navigation system should display consistent naming of places over time and location**		**27**	**2**	
47	**FriTab**	**Input**	**User can tell system that they no longer want to do an activity and why in order to personalise future recommendations**		21	1	
32	**FriTab**	**UI**	**Transportation mode availability/preferences**	Display different transport mode data to help user decide how to get to event		1	
33	**FriTab**	**UI**	**Privacy settings can be controlled via FriTab interface**		35	1	
48	**FriTab**	**UI**	**Display accessibility: visual user-interface for CPSN. Visual impairments must be considered.**	**Display accessibility: visual user-interface. Visual impairments must be considered. The interface should be customisable (font size and contrast)**	**35**	**1**	
49	**FriTab**	**UI**	**Provide a non-graphical visual interface for users with visual impairments.**	**Audio interface is also required for times when the user is focusing on**	**35**	**1**	

ID	Part of system	Feature	Requirement	Refinement	Interview reference (Page number)	Importance (1= High, 3 = low)	Status
				the task at hand rather than the leadthrough.			
50	**FriTab**	**UI**	**Interaction very easy**	**Interaction must be very easy and must use clearly-worded instructions**	**30**	**1**	
51	FriTab	UI	Interface must not irritate, distract or block view.			1	
36	FriTab	UI - Privacy	Users should be protected from revealing too much information about themselves	Users should be given information to discourage them from giving away too much information about themselves		2	
93	**FriTab**	**UI - recommendations**	**the system should take into consideration the safety of users when meeting other users**	**Provide information about safety (e.g. not to meet strangers in private places)**	**23**	**2**	
1	FriTab	User profiles	Operates with user profiles			1	
52	FriTab	User profiles	Can operate with different user profiles (including guest profile)			1	
53	FriTab (rehab)	Reminder system	Doctor can provide time and dosage information to system to notify users to take medication			3	
54	FriTab + FriWalk	Data	Track life-space mobility. Alert carer/doctor if it is reducing.			3	
55	FriTab + FriWalk	Data	Track walking distances. Alert carer/doctor if speed is slowing or gait is changing.			3	
56	FriTab + FriWalk	User profiles	Should recognise user and adapt to their profile accordingly			1	
109	**Friwalk**	**Context of use**	**The system should be usable in an outdoor environment**			**2**	
57	**FriWalk**	**Data**	**Monitors immediate environment for presence of people in order to avoid collisions**		32	2	
110	**Friwalk**	**Data**	**Monitor heart rate (nice to have)**			**3**	
87	**FriWalk**	**General**	**the FriWalk system should reduce fear of falling for users**		**21**	**1**	
98	**FriWalk**	**General**	**The walker should be able to move by itself**		**28**	**1**	
58	**FriWalk**	**Guidance**	**Provides navigation prompts in public spaces**	**Provides navigation prompts in public spaces if desired by the user**	**31**	**1**	
59	**FriWalk**	**Guidance**	**Avoids collisions with objects and people**		32	2	
60	**FriWalk**	**Information**	**Communicate walking pace to another user if permitted by user**	**Communicate walking pace to another user if permitted by user and in a non-constraining manner**	**26**	**3**	

ID	Part of system	Feature	Requirement	Refinement	Interview reference (Page number)	Importance (1= High, 3 = low)	Status
102	**Friwalk**	**Marketing**	**The Marketing materials should position why you would use it if you don't need a walker**			**1**	
61	**FriWalk**	**Physical form**	**Adjustable height for individual users**		28	1	
62	**FriWalk**	**Physical form**	**Should not require tight/strong grip**		25	1	
63	**FriWalk**	**Physical form**	**Stable, robust and heavy enough to avoid falls. Should be perceived as sturdy.**		25	1	
64	FriWalk	Physical form	Should not be able to lift it when turning.	Should not fall over when turning		1	
65	**FriWalk**	**Physical form**	**Easy to manoeuvre**		28	1	
66	**FriWalk**	**Physical form**	**Seat for user**		24	1	
86	**FriWalk**	**Physical form**	**The system should be as non-stigmatising as possible**		**20**	**1**	
97	**FriWalk**	**Physical form**	**The walker should be slim enough to allow for use in shops**		**28**	**2**	
67	**FriWalk**	**Recommender system**	**Set up with different activities for different users. Personalised exercises to improve balance and strengthen muscles.**		33	1	
101	**Friwalk**	**safety**	**Use of the walker should not interfere with normal walking pattern (i.e. length of gait)**			**1**	
104	**Friwalk**	**Safety**	**System should raise alarm to local support staff on request from user or after a prolonged delay.**			**1**	
100	**FriWalk**	**Safety**	**the FriWalk should stop if the user becomes detached from it**		**33**	**2**	
103	**Friwalk**	**Training**	**Pre-use evaluation of i) home/care home environment to assess suitability ii) environment where diagnostic tests being carried out**			**1**	
105	**Friwalk**	**Training**	**Training will be required for clinicians, care home staff and users**			**1**	
106	**Friwalk**	**UI**	**A Clinician interface will be provided for a) use of walker during diagnostics b) to assess diagnostic and rehabilitation test results.**			**1**	
107	**Friwalk**	**UI**	**Parkinson walking audio cues option**			**3**	
68	FriWalk	Usage	Can be used outdoors in close vicinity to the hospital or museum (or other key location) with reduced functionality			2	
108	**Friwalk (diagnostic)**	**Diagnostic tests**	**Support trained personnel to administer the SPPB diagnostic tests and record results.**			**1**	

ID	Part of system	Feature	Requirement	Refinement	Interview reference (Page number)	Importance (1= High, 3 = low)	Status
69	FriWalk (generic)	Availability	Be located at key locations such as shopping centres, museums and sports centres.			1	
70	**FriWalk (generic)**	**Physical form**	**Should be able to carry some a few items of shopping for the user**		27	1	
71	FriWalk (rehab)	Availability	Be located at hospitals or clinics.			1	
72	FriWalk (rehab)	Data	Monitors user gait	Monitor user gait and record to provide feedback to clinician and patient		1	
73	FriWalk (rehab)	Data	Monitors user posture	Monitor user posture and record to provide feedback to clinician and patient		1	
74	FriWalk (rehab)	Data	Monitors user speed	Monitor user speed and record to provide feedback to clinician and patient		1	
75	FriWalk (rehab)	Data	Monitors user's balance	Monitor user balance and record to provide feedback to clinician and patient		1	
76	FriWalk (rehab)	Data	Monitor posture and distance from walker. Correct user if necessary	Monitor user posture and distance from walker and record to provide feedback to clinician and patient		1	
77	FriWalk (rehab) + FriTab	Information	Recommend that user changes posture during an activity			1	
78	**FriWalk (rehab) + FriTab**	**Recommender system**	**Recommends exercises to users**	**Recommends exercises to users in accordance with their confidence and ability**	**36**	**1**	
79	FriWalk + FriTab	Information	Be able to provide guided tours of public spaces such as museums			1	
80	FriWalk + FriTab	Physical form	FriTab should be able to easily attach and detach from FriWalk			1	
81	**FriWalk + FriTab**	**UI**	**Haptic feedback will be provided to users if they desire**		31	1	
111	**Friwalk/Fritab**	**UI**	**The user lead-through should instruct the user on how to complete the exercise properly (this may require video or animation)**			**1**	
90	**General**	**General**	**the system will need to be linked to the internet to provide recommendations**		**23**	**1**	
83	**General**	**Introduction to system**	**The system should be introduced to and explained to users by someone to maximise confidence and encourage use**		**16**	**1**	

ID	Part of system	Feature	Requirement	Refinement	Interview reference (Page number)	Importance (1= High, 3 = low)	Status
95	General	Recommender system	The system should detect when a user is spending too long at home and should recommend an activity	Rejected – too many variables to decide how long is too long. Would also require AI to make this decision.	26	2	Rejected

Appendix 4: Evaluation card template[5]

<USE CASE NAME> (use *case<use case id>*)	
Clinical utility	*<How relevant the individual professional considers the current scenario in terms of clinical utility>*
Weaknesses	*<What is the individual opinion of the professionals regarding the weaknesses of the evaluated scenario>*
Strengths	*<What is the individual opinion of the professionals regarding the strengths of the evaluated scenario>*
Suggestions	*<Arisen suggestions>*

[5]Also, when filling the evaluation cards, the participants also provided his/her professional profile.

Appendix 5: Slides used for the focus group with professionals

ACANTO project

- H2020
  - PHC-19-2014: Advancing active and healthy ageing with ICT: service robotics within assisted living environments.
- Consortium:
  - Università degli Studi de Trento.
  - Visual Tools S.A.
  - Foundation for Research and Technology Hellas.
  - University of Northumbria at Newcastle.
  - Università degli Studi di Siena
  - Institut National de Recherche en Informatique et en Autmatique.
  - Servicio Madrileño de Salud.
  - Siemens Aktiengesellschaft Österreich.
  - Telecom Italia S.p.a.
  - ATOS Spain S.A.

ACANTO project

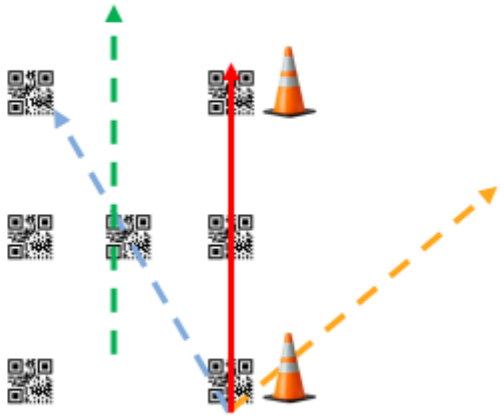
- *FriWalk* → robotic walker
  - Perception of the user and the environment.
  - Social context interpretation.
  - Guidance.
  - Emotion detection.
- *Cyber-Physical-Social-Network* → social network
  - User profiles.
  - Circles.
  - Recommendations.
- *FriTab* → interface with the system

Some social scenarios

- Older adult (OA) that uses *FriTab* to meet similar people.
- OAs that meet using *FriTab* and go together to the mall to make some shopping assisted by the *FriWalk*.
- *FriTab* recommends an OA to go to a conference (the system provides the user detailed information on how to get to the place on time).
- OA that through *FriTab* proposes other users to visit an exhibition.
- *FriTab* proposes an OA to go to a group visit in a museum where there are *FriWalks*.
- An OA that uses *FriWalk* regularly and the systems detects worrying changes in his/her gait. The doctor is notified.
- ...

FriWalk prototype

- Straight line



FriWalk prototype

- Free

Clinical scenarios

REHABILITATION AND SOCIAL USE
(use case 10)

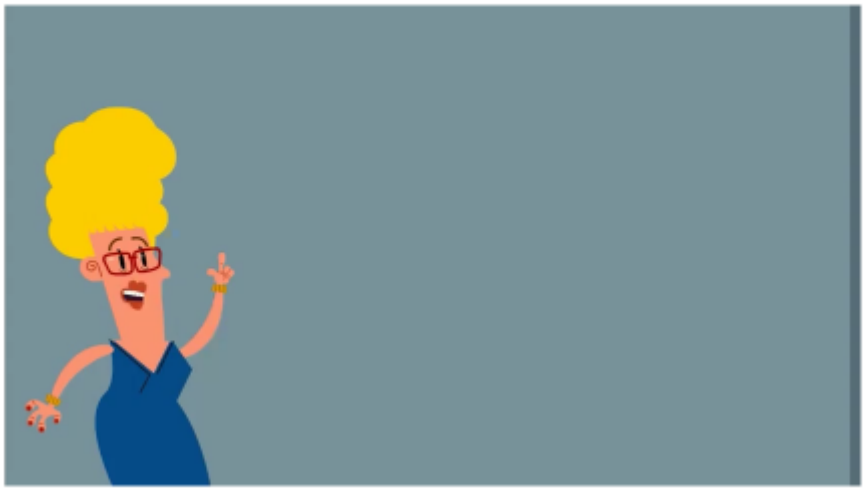
Clinical scenarios

REHABILITATION AND SOCIAL USE
(use case 10)

Demographics	Manuel is a 74 year old man who lives alone.
Location	He lives in an apartment in Madrid.
Lifestyle	He recently suffered a bad fall which has made it difficult for him to get around. He is undergoing therapy at a local falls clinic and is slowly getting better. At the clinic he is given a FriWalk to help him move around and to give him exercises to perform at home.
Gap for activity	Back at home, Manuel is now afraid to go out. He worries that he might fall with no one to help him.
Desire for activity	He would like to go back to his local museum because he has not been there since his fall.
Recommendation	One day, the FriTab on his FriWalk says that he should go to the local museum. It tells him that his friend, Francisco, who also has a FriTab, is going to the museum and they could go together.
Basis for recommendation	Every day, the FriWalk has asked Manuel to do exercises to help improve his balance. It has noticed that his balance has improved. It thinks he will be able to go out with the help of his FriWalk.
Decision	Manuel agrees to go to the museum. He feels reassured by the help
Implementation	The next day, Francisco visits Manuel's house and they walk to th
Result	They both enjoy their visit to the museum. Because Manuel can are going on his FriTab, he decides he will try to go out with them m

Clinical scenarios

FUNTIONAL DECLINE
(use case 11)



Clinical scenarios

FUNTIONAL DECLINE
(use case 11)

Demographics	Manuela is an 83 year old woman who lives with her husband
Location	She lives in a nursing home with her husband in Getafe, Madrid
Lifestyle	She has been slightly depressed since she and her husband moved to the nursing home. She has lost some sight during the last years, and she does not know her way around the new neighbourhood or the venues and activities there.
Gap for activity	She is unmotivated, she does not know the surroundings of the nursing home where she is living and does not feel confident enough to go outside the nursing home without her husband.
Desire for activity	She would like to feel more confident to perform activities on her own, and to regain some independence.
Arrival of system	After Manuela has suffered a fall, she has a visit with Dr. Sánchez, her geriatrician. Dr. Sánchez knows that Manuela lives in a nursing home that has some FriWalks. Dr. Sánchez sets up an exercise plan for Manuela that she can do at the nursing home.
Using FriWalk features	Some mornings, while her husband is out with their friends, Manuela goes to the gym in the nursing home. The nursing home counts on 2 FriWalks that are shared among all residents subscribed to an exercise program. When one of the FriWalk gets available, Manuela takes it and "logs in". The FriWalk guid through her exercise program. Once she finishes, the FriWalk asks her how she has been.
Recommendation	After performing an exercise session at the nursing home, the FriTab in the FriWalk te group of people from the nursing home will be attending a watercolour expo nea venue she did not know.
Basis for recommendation	Manuela has regained a good functional status, and she should start doing act
Decision	Manuela has regained a good functional status and feels more confident abo apacities, so she agrees to go to the watercolour expo.

Clinical scenarios

REHABILITATION AFTER HIP FRACTURE
(use case 12)

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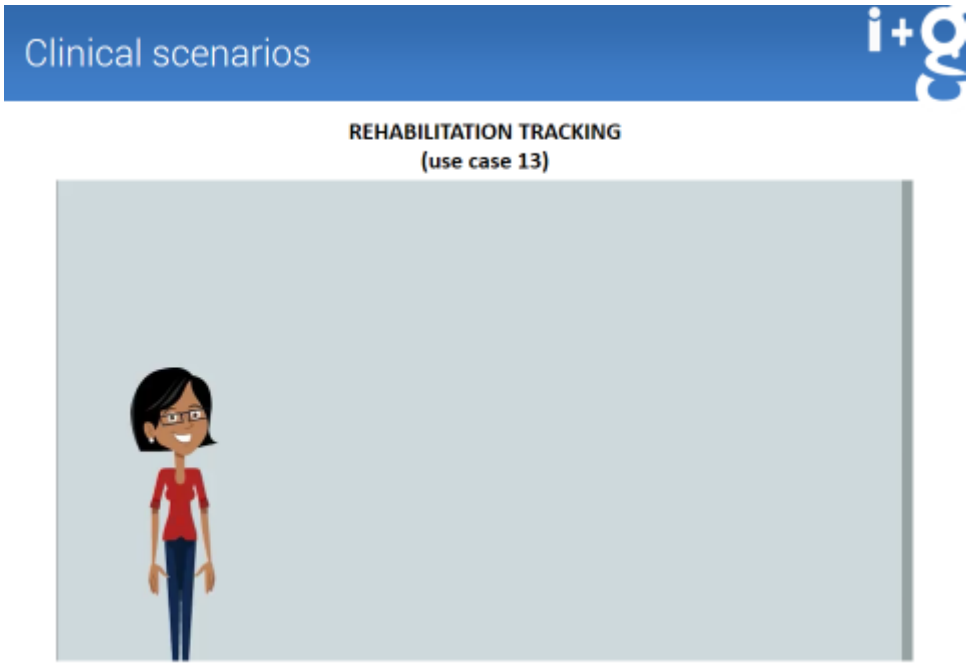
Clinical scenarios

REHABILITATION AFTER HIP FRACTURE
(use case 12)

Demographics	José is an 80-year-old man who lives alone
Location	He lives in a small, old flat in Getafe, Madrid
Lifestyle	José was quite active before the fracture, and enjoyed going in the morning to a bar near his house with his friends.
Gap for activity	José is feeling some pain when he walks, and he does not know how much exercise would be good for him.
Desire for activity	José has the idea that everyone he knows that has suffered a hip fracture has died in the following year, and he is scared it might happen to him.
Arrival of system	José starts using the FriWalk in order to stand up and walk through the hospital alleys. When he is discharged, the geriatrician recommends José with a Day Centre near his house where they have some FriWalks, as José lives far from the Hospital and it would take him too long to follow the exercise program at the Day Hospital. The geriatrician then sets an exercise program for José.
Using FriWalk features	José goes to the Day Centre three times per week early in the morning. Ther… the FriWalk to perform the recommended exercise program. He can als… Sánchez whether he feels pain or not, and how tired he has felt af…
Basis for recommendation	It is extremely important to regain a good level of functional c… in order to avoid disability and even death. Factors that might … of exercise include pain or fear or falling, so the FriWalk can he…


Clinical scenarios
REHABILITATION TRACKING
(use case 13)

Clinical scenarios

REHABILITATION TRACKING
(use case 13)

Demographics	Ana is a 76-year-old woman that has some blood pressure problems. She lives in a nursing home and needs a crutch to walk.
Gap for activity/system intervention	One day she went to the supermarket and did not see the step of the sidewalk. She felt and broke her hip. She was taken to the hospital and had to wait 4 days to have an operation, since she was taking medicines for the blood pressure and the treatment had to be interrupted. She spent 3 more days at the hospital after surgery, and when the surgery wounds allowed it she went to the functional recovery unit for rehabilitation instead of going back to the nursing home as she was not able to stand up immediately.
Arrival of system	After the rehabilitation at the hospital she can stand up with a FriWalk. She has received training on the type of exercises she has to do with the FriWalk and she goes back to the nursing home.
Using FriWalk features	She must perform a series of exercises every day and the summary of those exercises will be reported to the geriatrician. The geriatrician notices that Ana is not doing her exercises. She feels unmotivated after the fall, because of the pain she feels and also because she is afraid of falling again. The geriatrician contacts the nursing home personnel and they try to educate and motivate Ana to do the exercises.
Result	She feels better after this talk and in the subsequent revisions one month (surgery) and three months the geriatrician realizes that she is improving. The monitoring continues until she goes back to the hospi the revision, after one year from the surgery. She is able to do the same activities she did befo using the FriWalk. Without being monitored with the FriWalk, probably the rehabilitation more time and this woman would have not recovered well from the fracture.

Clinical scenarios

DIAGNOSTICS TOOL
(use case 15)

Demographics	Vicente is an 88 years-old man who lives alone.
Location	He lives in a quiet neighbourhood in Getafe.
Gap for activity	Vicente is having trouble with his balance and he is afraid that he is going to fall. He doesn't want to walk alone and leave his house anymore; his life space is being reduced and he is getting worse every day. His GP visits him at home because he is not coming to get his usual medication prescription. The GP performs a basic physical examination and it is not clear why his balance is getting worse.
Desire for activity	The GP refers him to the geriatrician for a complete functional assessment.
Arrival of system	The occupational therapist and the geriatrician can perform a complete and more accurate examination of the gait analysis.
Recommendation	The system recommends more activities and exercises. The occupational therapist and the geriatrician can see the evolution in a more graphic and specific way with the help of the FriWalk.
Basis for recommendation decision	Next month, when Vicente visits the Day Hospital and a new automatic assess performed, the results are positive, showing that his physical performanc He is more confident about his balance and start to leave his home.

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Refinement of the user requirements
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Hospital Universitario de Getafe
fundacion
Universidad Europea de Madrid

Appendix 6: Filled evaluation cards (professionals)

Occupation: Physiotherapist.

REHABILITATION AND SOCIAL USE (use case 10)	
Clinical utility	It is a good method for rehabilitation monitoring.
Weaknesses	It is not very beneficial for people who may walk indoors, from a rehabilitation point of view.
Strengths	It is minimally invasive.
Suggestions	

FUNCTIONAL DECLINE (use case 11)	
Clinical utility	It is a good method to present and manage exercise programs. It is very useful to guide the patient through the neighbourhood and for the adaptation to new environments.
Weaknesses	As the scenario is described, the walker does not seem necessary. It would be very useful to show the user his/her new environment.
Strengths	It is possible to record the compliance with the exercises program; the doctor can make a good monitoring.
Suggestions	

REHABILITATION AFTER HIP FRACTURE (use case 12)	
Clinical utility	It is a good tool to communicate patients and doctors. It is possible to control the exercise program so new exercises may be prescribed. It is also useful in the final stages of the rehabilitation process.
Weaknesses	The walker cannot be used in the early stages without proper supervision.
Strengths	The provided feedback to both physicians and patients.
Suggestions	Monitoring is necessary.

REHABILITATION TRACKING (use case 13)	
Clinical utility	It is a good way to communicate among professionals.
Weaknesses	
Strengths	
Suggestions	

DIAGNOSTICS TOOL (use case 15)	
Clinical utility	
Weaknesses	It seems difficult to integrate the walker into the existing tests.
Strengths	

Suggestions	It could be a good tool to monitor patients' evolution.

Occupation: Geriatrician.

REHABILITATION AND SOCIAL USE (use case 10)	
Clinical utility	Generally useful.
Weaknesses	Architectural barriers in the patient's home must be known and assessed. Homes must be previously evaluated.
Strengths.	The provided feedback.
Suggestions.	

FUNCTIONAL DECLINE (use case 11)	
Clinical utility.	Not much.
Weaknesses.	
Strengths.	
Suggestions.	Prescribers should not be necessarily a geriatrician. It is useful to help users know new environments.

REHABILITATION AFTER HIP FRACTURE (use case 12)	
Clinical utility.	Generally useful.
Weaknesses.	The walker should be left as soon as possible and the patient should be moved to other technical aids.
Strengths.	Monitoring feedback.
Suggestions.	

REHABILITATION TRACKING (use case 13)	
Clinical utility.	Generally useful.
Weaknesses.	
Strengths.	
Suggestions.	It could be used at a nursing home.

DIAGNOSTICS TOOL (use case 15)	
Clinical utility.	
Weaknesses.	It could be useful if the patient walked with the walker daily.
Strengths	
Suggestions	It could be a good tool to monitor patients' evolution.

Occupation: Geriatrician.

REHABILITATION AND SOCIAL USE

(use case 10)	
Clinical utility	It is possible to perform rehabilitation exercises at home.
Weaknesses	Homes must be evaluated. Sensory deprivation.
Strengths	Useful to continue the rehabilitation at home.
Suggestions.	The walker should have an emergency button. In the early stages of rehabilitation, the exercises program should be monitored by physiotherapist.

FUNCTIONAL DECLINE (use case 11)	
Clinical utility	It could be useful to improve adaptation at home.
Weaknesses	
Strengths	It is useful to know the new neighbourhood.
Suggestions	It is not a functional impairment; it is an adjustment disease.

REHABILITATION AFTER HIP FRACTURE (use case 12)	
Clinical utility	It is useful to carry out the rehabilitation at a day centre.
Weaknesses	
Strengths	It allows us to access data related to the exercise program. It is a good tool for evaluation.
Suggestions	

REHABILITATION TRACKING (use case 13)	
Clinical utility	
Weaknesses	It is necessary to have trained personnel at the nursing home.
Strengths	
Suggestions	

DIAGNOSTICS TOOL (use case 15)	
Clinical utility	Patient progression can be assessed.
Weaknesses	The walker could modify the gait speed.
Strengths.	It could serve as a tool for assessment of progress.
Suggestions	It could serve as a monitoring tool for functional recovery.

Occupation: Nurse.

REHABILITATION AND SOCIAL USE (use case 10)

Clinical utility	It is useful to maintain physical activity.
Weaknesses	We must know the architectural barriers in the patient's home and we must assess the obstacles at home.
Strengths	It is a good tool to assess independence recovery.
Suggestions	It would be necessary to make a preliminary assessment of the places where the walker will be used.

FUNCTIONAL DECLINE (use case 11)	
Clinical utility	Improves fitness if the patient really carries out the exercise program.
Weaknesses	We have to evaluate if the walker is necessary inside or outside at nursing home.
Strengths	The walker can be used to improve the adjustment disorder.
Suggestions	

REHABILITATION AFTER HIP FRACTURE (use case 12)	
Clinical utility	It is useful to continue the rehabilitation process.
Weaknesses	It is necessary that the physician is proactive to know if the patients are performing the exercise programs.
Strengths	The walker helps to regain independence.
Suggestions	

REHABILITATION TRACKING (use case 13)	
Clinical utility	It is useful to monitor the physical performance of the patients.
Weaknesses	The responsible for the process is not clear for this scenario.
Strengths	The patient can be encouraged to adhere to the treatment and thus to regain functionality sooner.
Suggestions	

DIAGNOSTICS TOOL (use case 15)	
Clinical utility	It could be useful to monitor the exercise program.
Weaknesses	
Strengths	If the patient does the exercise program, we will can see the positive results.
Suggestions	

Occupation: Geriatrician.

REHABILITATION AND SOCIAL USE (use case 10)	
Clinical utility	It is a good tool to regain confidence and improve the fear of suffering further falls. We can assess the gait pattern helping the diagnoses of falls.
Weaknesses	Homes must be evaluated.

Strengths	The walker improves patient safety, adjustment disorder and the social isolation caused by falls. It can be useful to widen the life space.
Suggestions	To improve gait pattern in patients with Parkinson disease, it would be an option to play a sound in order to provide patients cues to help the gait.

FUNCTIONAL DECLINE (use case 11)	
Clinical utility	The walker is useful for its social and emotional use.
Weaknesses	The name of the scenario does not seem correct.
Strengths	It can be useful for the adjustment disorder.
Suggestions	

REHABILITATION AFTER HIP FRACTURE (use case 12)	
Clinical utility	It is a good tool to perform rehabilitation at home.
Weaknesses	The walker cannot be used in early the stages of the exercise program.
Strengths	The walker can improve muscle weakness.
Suggestions.	The physician must instruct the patients on how to use the walker.

REHABILITATION TRACKING (use case 13)	
Clinical utility	We can monitor the exercise program.
Weaknesses	
Strengths	The walker reports to the physician if the patients do not comply with the exercise program.
Suggestions.	

DIAGNOSTICS TOOL (use case 15)	
Clinical utility	
Weaknesses	It is not useful to evaluate gait speed and SPPB.
Strengths	
Suggestions	It could be a good tool to monitor the evolution of the patients.

Occupation: Geriatrician.

REHABILITATION AND SOCIAL USE (use case 10)	
Clinical utility	Generally useful.
Weaknesses	Homes must be evaluated.
Strengths.	It provides support both to rehabilitation and social activities.
Suggestions.	It could be used in rehabilitation at home. The walker should be focused on a strictly temporary use.

FUNCTIONAL DECLINE (use case 11)	
Clinical utility	It could be used to know the neighbourhood. The Walker must be prescribed by the nursing home personnel.
Weaknesses	
Strengths	
Suggestions	The staff of the nursing home should be responsible for managing the process.

REHABILITATION AFTER HIP FRACTURE (use case 12)	
Clinical utility	
Weaknesses	
Strengths	It could be used to continue the exercise program at nursing home.
Suggestions	The walker must be used temporary. Professionals need specific training on the walker. The staff of the day centre should be responsible for managing the process.

REHABILITATION TRACKING (use case 13)	
Clinical utility	
Weaknesses	
Strengths	
Suggestions	

DIAGNOSTICS TOOL (use case 15)	
Clinical utility	
Weaknesses	It seems difficult to integrate the walker into the existing tests.
Strengths	
Suggestions.	It could be a good tool to monitor.

Occupation: Others.

-EVALUATION OF USAGE SCENARIOS-

REHABILITATION AND SOCIAL USE (use case 10)	
Clinical utility	
Weaknesses	
Strengths.	It is a good tool to improve independence.
Suggestions.	The Walker should have an emergency button. Oblique wheels could provide better stability.

FUNCTIONAL DECLINE (use case 11)	
Clinical utility	It can be helpful to regain confidence.
Weaknesses	It is not a clinical case.
Strengths.	It is useful to adjustment disease.
Suggestions.	

REHABILITATION AFTER HIP FRACTURE (use case 12)	
Clinical utility	
Weaknesses	
Strengths.	
Suggestions.	The walker could have a heart rate sensor to monitor patient's status.

REHABILITATION TRACKING (use case 13)	
Clinical utility	
Weaknesses	
Strengths.	
Suggestions.	

DIAGNOSTIC TOOL. (use case 15)	
Clinical utility	
Weaknesses	It is not a diagnostics tool.
Strengths	
Suggestions.	It could be a good tool to monitor patients' evolution.

Occupation: Nurse.

REHABILITATION AND SOCIAL USE (use case 10)	
Clinical utility	The walker could be used those days when the patient does not go to the rehabilitation clinic.
Weaknesses	Homes must be evaluated.
Strengths	It is a good tool to regain confidence.
Suggestions.	Homes and nursing homes must be evaluated to know if the walker could be used there.

FUNCTIONAL DECLINE (use case 11)

Clinical utility	
Weaknesses	It is a social case.
Strengths	
Suggestions	It could be useful to know the new neighbourhood.

REHABILITATION AFTER HIP FRACTURE (use case 12)	
Clinical utility	It is possible to perform rehabilitation exercises out of the clinical environments.
Weaknesses	
Strengths	The system can help improving adherence to the treatment.
Suggestions	The exercise program should be supervised by a physician. We have to improve the physical independence. The walker must be used temporary.

REHABILITATION TRACKING (use case 13)	
Clinical utility	
Weaknesses	
Strengths.	
Suggestions.	

DIAGNOSTICS TOOL (use case 15)	
Clinical utility	It could be useful to complete the diagnosis.
Weaknesses	The walker modifies gait speed, so that the results are unreliable.
Strengths	The walker could provide higher accuracy in the measurements.
Suggestions	It is useful to monitor the evolution of the patients.

Occupation: Geriatrician.

REHABILITATION AND SOCIAL USE (use case 10)	
Clinical utility	It is a good tool to monitor patients when they are waiting at home for rehabilitation. It is a good for providing feedback. It builds confidence.
Weaknesses	
Strengths	It provides support both for rehabilitation and for social activities.
Suggestions	The walker should have an emergency button.

FUNCTIONAL DECLINE (use case 11)	
Clinical utility	Social activities. It is useful for the adjustment disease.

Weaknesses	It is not very useful in rehabilitation.
Strengths	Social support.
Suggestions	It is not a functional impairment case; it is adjustment disorder. Nursing home personnel have to teach the users on how to use the walker.

REHABILITATION AFTER HIP FRACTURE (use case 12)	
Clinical utility	It is a good tool to maintain adherence to the prescribed treatments.
Weaknesses	The walker must be temporary.
Strengths	It allows physicians to access the information related to the exercise program.
Suggestions	It would be a good idea to play explanatory videos explaining the patients how to perform a specific activity. In this scenario, the staff of the day centre should be responsible for managing the process.

REHABILITATION TRACKING (use case 13)	
Clinical utility	
Weaknesses	
Strengths.	It provided feedback.
Suggestions.	

DIAGNOSTICS TOOL (use case 15)	
Clinical utility	
Weaknesses	It does not seem useful for diagnosis.
Strengths	
Suggestions	It could incorporate a gait speed sensor to assess the patient's progress in the rehabilitation treatment.

Appendix 7: Questionnaires filled up by the older adults

Gender	Male	Female			
Education	Primaryschool	Secondaryschool	University	Other	
¿Do you have a smartphone ?	Yes	No			
If you have one, what do you use it for (mainly)?	Talking	e-Mail	Social networks	Internet	Other
Do you have a PC?	Yes	No			
If you have one, what do you use it for (mainly)?	Skype or similar	Social networks	Internet	Other	
Do you perform any kind of physical activity?	No	Walking	Gym	Other	
Ifnot, why?	…….				

If you do perform physical activity, do you do it alone or with other(s)?	Alone Withother(s)
If you perform physical activity with other(s), who are your usual companions ?	…….

Appendix 8: Slides used for the focus group with older adults

1. You will think in someone (maybe yourself) with whom you identify the presented scenario the most.
2. We will make some questions related to the person you have thought about.
3. We will comment it alltogether.
4. At the end, we will try to propose a new scenario.

Manuel

Scenarios

Manuel

Manuel has suffered a recent fall and cannot move properly

Who reminds you Manuel?

Manuel has suffered a recent fall and cannot move properly

Why?

Scenarios

Manuel

Scenarios

Manuela

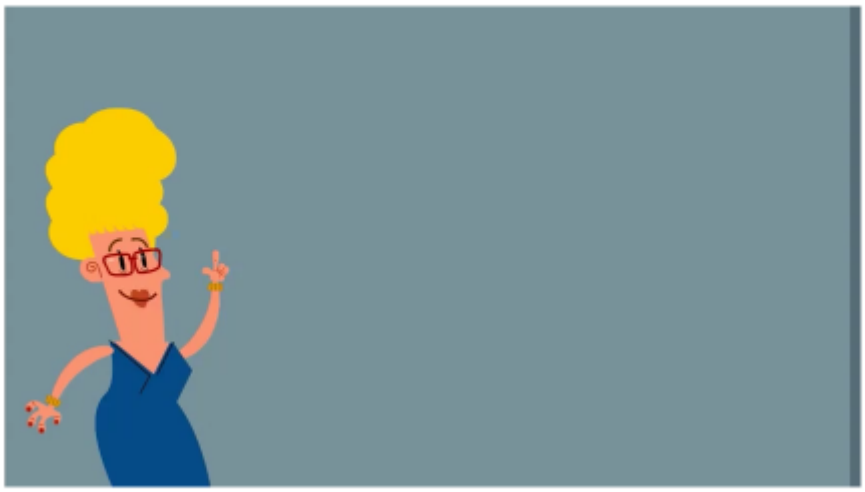
Scenarios

Manuela is a bit depressed; she lives in a nursing home an doesn't know the neighborhood. Besides, she is loosing some vision

Who reminds you Manuela?

Scenarios

Manuela



Scenarios

Manuela is a bit depressed; she lives in a nursing home an doesn't know the neighborhood. Besides, she is loosing some vision

Why?

Scenarios

Manuela

José

José

Scenarios

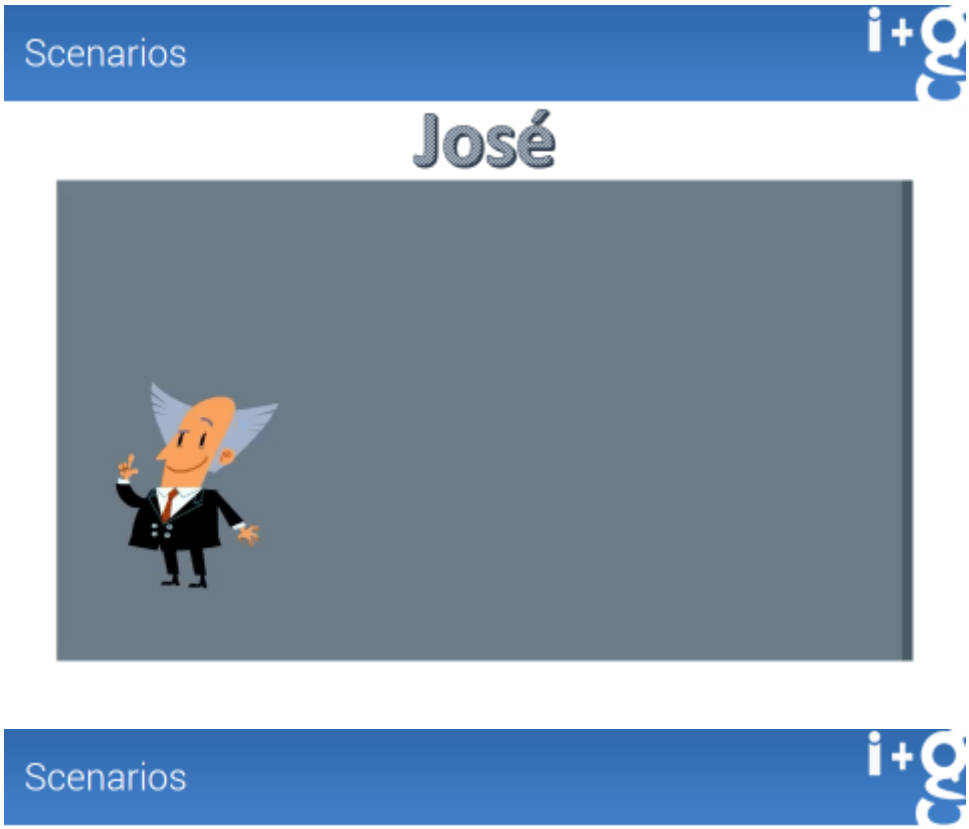
José lives alone and broke his hip recently

Who reminds you José?

Scenarios

José lives alone and broke his hip recently

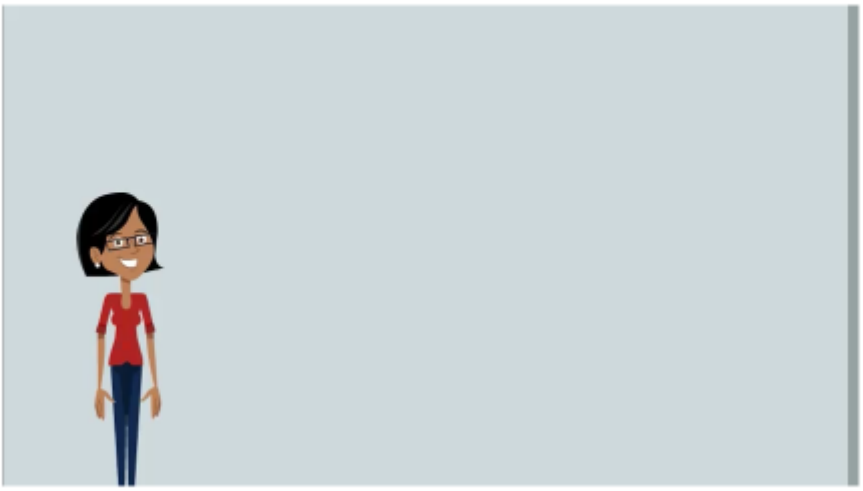
Why?



Ana

Scenarios

Ana



Scenarios

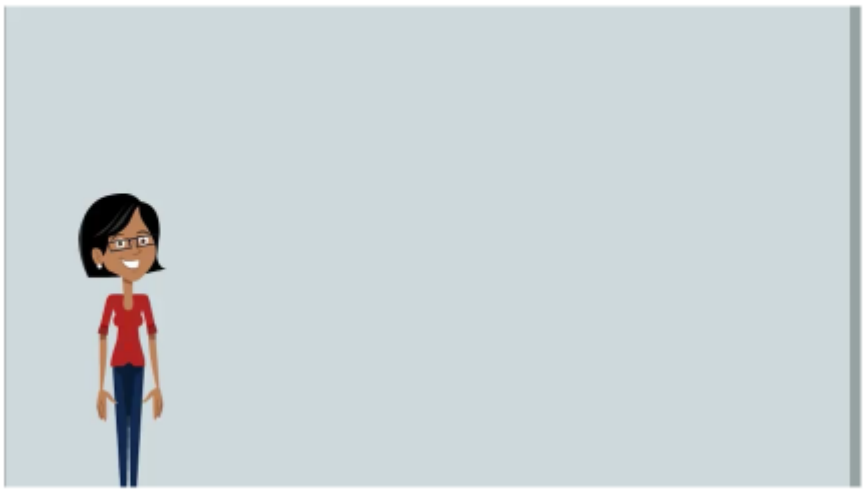
Ana lives in a nursing home and recently broke her hip

Who reminds you Ana?

Ana lives in a nursing home and recently broke her hip

Why?

Ana



another?

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