Accompany

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SHORT REPORT

Deliverables that are of a nature other than written "reports", such as "prototypes", "demonstrators" or "others", should also be accompanied by a short report, so that the European Commission has a record of their existence.

This deliverable is a report on user and system requirements and a first outline of system functionality. It is an outcome of T1.2 and T1.3. This deliverable will provide a guideline for required system functionality which will also include key performance indicators that are to be met by each of the development work packages.

1 Introduction

This document is the second deliverable in the user needs work package WP1. It is a follow up of D1.1: *Status of elderly care in Europe and the potential for service robotics*. In D1.1 we reported the results of an inventory of problematic activities in independent living from the literature and of current care provisions supporting independent living in four European countries. D1.2 is the next step in the assessment of user needs (patients and caregivers) and societal needs. In particular, this deliverable aims at the formulation of an initial scenario for the Accompany robot development. This initial scenario addresses the desired functionality of the robot and supports the users in domains that are desired in maintaining independence in living at home. D1.2 specifies the needs, outlined by the literature and societal perspective on care provision reported in D1.1, on the basis of the of user feedback (user group meetings). In D1.2 the technical feasibility of the initial Care-O-bot® 3 robot and the development potential within the project is used to formulate system requirements. These system requirements are directed by the formulation of use and application scenarios of the Accompany robot system supporting elderly in maintaining their independence in their home situation. The result of this deliverable is this scenario and its development (by work packages 2, 3, 4, and its successful integration under WP5) which will be taken the target for the initial development of the robot system in the Accompany project.
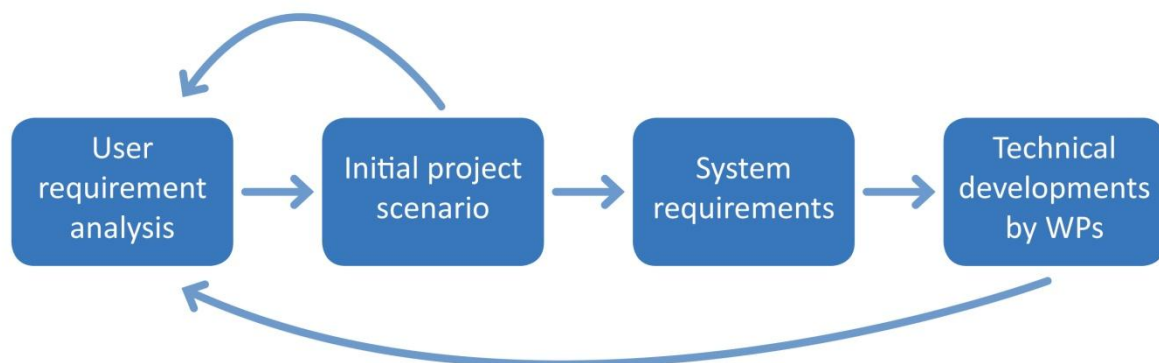
Figure 1. Progress in WP1 from user requirement elicitation to scenario definition and formulation of system requirements

As the scenario is influencing the development of the robot, its delivery was set in project month 6, meeting the time schedule accommodating required technical work still being steered by the assessed user needs. Unfortunately, the time schedule for the user needs assessment itself proved to be too tight and some delay resulted while not all user group data has been included in the analysis so far. The data collection will be completed but the results so far show a very coherent outcome across the three user centres. The confidence in these outcomes so far, combined with the need for the scenario to keep the planning of the Accompany project as a whole on track resulted in producing this deliverable at this stage.

Chapter 2 of this deliverable reports the results from the user groups. This is the third part of the user needs assessment (the results of an inventory of problematic activities in independent living from the literature and the current care provisions supporting independent living in four European countries of D1.1 are the first two parts). In the third chapter the system requirements are outlines in general terms and in the fourth chapter the initial scenarios are described and the further steps foreseen in the development of the scenarios.

2   User requirements

As outlined above, the user needs assessment reported in D1.1 was extended and detailed by means of focus groups with users. The aim of these participatory groups was to qualitatively investigate the nature of the problems people face in trying to remain living independently. This does not only concern elderly with increasing disability to maintain independence but also their informal and professional care givers.

As the general public is not familiar with the concept of service robotics in their daily life, the user groups cannot be effectively questioned regarding their view on the application of the Care-O-bot® 3 in support of their independence in daily life. Such questions would lead to speculation based on unspecified prejudice and would potentially yield meaningless data with respect to the project developments. To avoid this the first round of user group meetings reported in this deliverable concerned the problems people experience in daily life threatening their independent living. This in contrast, is of course well within the expertise of elderly and their caregivers. The background of the study, the Accompany project, was not kept from the participants but the possibility of a robotic solution for the reported problems was only introduced after the problem assessment session itself was completed. In the following rounds of user group meetings (planned for project months 8 and thereafter as shown by figure 2), the robotic solution will be the topic of discussion. This meeting will be guided by the envisaged scenarios or the evaluation of intermediate prototypes according to the development stage of the project. Figure 2 shows the schedule of meetings planned to implement our approach to the User Requirement. For example, meetings 2 and 4 will utilise the project scenarios alongside audio-visual material aiding the scenarios, while meetings 3 and 5 will utilise the project prototypes either directly or by means of videos. Nonetheless, the role of these meetings is to perform formative evaluation of the project developments.
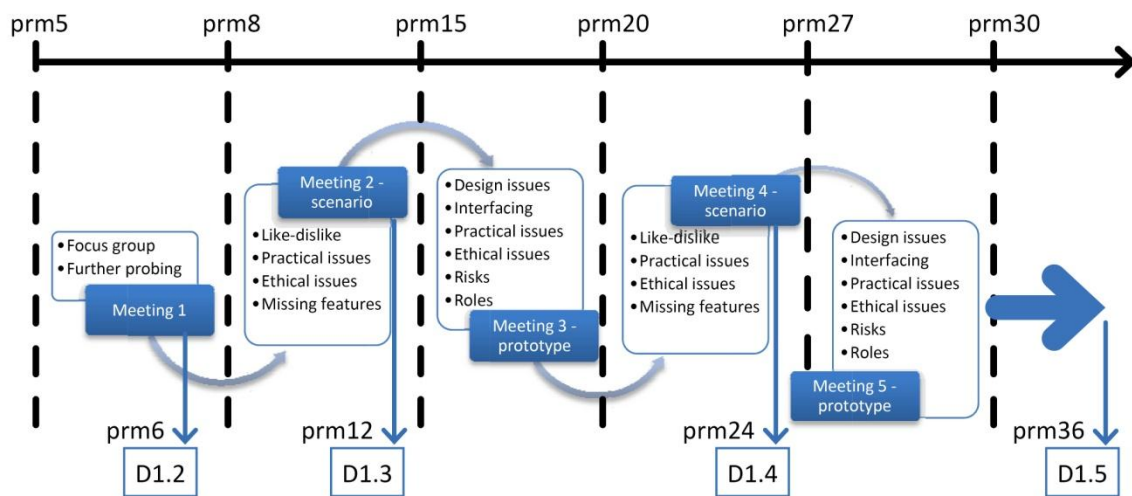
Figure 2. Preliminary plan of focus group meetings as the project developments progress

As in D1.1, for the reporting of the collected problems the International Classification of Functioning (ICF) the World Health Organization (WHO) is again applied in this deliverable to support harmonisation [1].

2.1 Focus groups

Different focus group meetings were held in the Netherlands, UK, and France. For the data collection, focus group sessions were used to first identify viewpoints of individual participants and then group consensus. Focus group sessions are practical by ensuring that all participants contribute to the outcome of the meeting, whilst the group discussion provides deeper understanding of the issues discussed and facilitates the collection of comprehensive data. Three separate target groups were included: 1) elderly persons, 2) formal caregivers, and 3) informal caregivers. Separate focus groups were held for each of the three target groups, so that perspectives of the different groups could be captured.

2.1.1   Participants

Elderly persons and formal caregivers were contacted through care organizations. Informal caregivers were contacted through personal networks and through care organizations. Elderly persons were selected based on three criteria: 1) aged 60+, 2) living at home, and 3) receiving home care. The selection of formal caregivers was based on their work activities/profession. It was required that they worked closely with independently living elderly persons on at least a weekly basis. Informal caregivers had to meet one of the two criteria: 1) take care of an independently living elderly person on at least a weekly basis, or 2) to have taken care of an independently living elderly person on a weekly basis in the last year. During the recruitment the term robotics was mentioned,

as well as the goal of the Accompany project. However it was clearly stated that the particular focus of this focus group would not be on the use of robots.

In total 96 persons participated in the study:

- Thirty-two elderly persons (7 male, 25 female) with a mean age of 78.4 years (from 60 to 95 years) participated in focus group meetings in the Netherlands (7) and France (25). All elderly persons were still living at home and received some form of care assistance (e.g. home care, telecare).

- Thirty-two professional caregivers (1 male, 31 female) participated in focus group meetings in the Netherlands (6), UK (4) and France (22). Caregivers' professions varied from care workers, nurses, psychologists to managers. All professional caregivers worked closely with elderly.

- Thirty-two informal caregivers (2 male and 30 female) participated in focus group meetings in the Netherlands (7), UK (5) and France (20). Informal caregivers took care of (one of) their parents, their spouse, neighbour, or their aunt. In two cases the elderly person taken care of was recently institutionalised and in one case the elderly person had recently passed away.

2.1.2   Procedure

The focus groups were carried out in separate groups of 4-10 participants in a room with a round table formation. Every participant received a marker and post-it notes. After the introduction and signing of the informed consent, participants were given one of the following questions (one for each group type):

- Elderly persons: *Which problematic activities in (your) daily life are threatening (your) independent living?*
- Formal caregivers: *Which problematic activities in the daily lives of your clients are threatening their independent living?*
- Informal caregivers: *Which problematic activities in the daily lives of the person you care for are threatening his/her independent living?*

The first assignment given to all participants was to individually write down as many activities they could think of on the post-its answering the given question (one activity per post-it). They were asked to stick their post-its (randomly) on one surface when finished writing. Secondly, the participants were asked, as a group, to cluster all the gathered material per topic. During this clustering phase, discussion among participants was stimulated and more clarification was asked when needed. After clustering, all subgroups/topics were again discussed in the group. Finally participants were asked which group/topic they thought was the most important for independent living. Taking this step ensured the transition from individual viewpoints to group consensus. When participants had difficulty picking just one problem, the multidimensional nature of the problems was further discussed. Participants who found the question too difficult to respond were asked to answer the following question: *If we are going to create something to solve one of these problems, which problem should we solve first?* The duration of the focus groups varied between 1.5 and 2 hours.

2.1.3   **Data analysis**

Pictures were taken of the final clustered post-its and all activities written on the post-its were copied per group/topic. A short summary of every group/topic was recorded, as well as a general description of the whole session. A final list was composed for every focus group of those activities participants felt needed solving first. The validation of this final list will take place in the next focus group meeting in project month 8 (see Figure 2).

2.2 Results

From the focus group meetings a total of forty-three different problems were gathered (see Table 1.1 and 1.2). Similar to the literature study of D1.1, the majority of the collected problematic activities raised during the focus group meetings could be grouped into section d, *Activities and Participation*, of the ICF. This section of the ICF is about activities people perform. The activities participants mentioned during the focus group meetings were (when possible) linked to the ICF. For instance: opening the front door is not an activity that was mentioned specifically in the ICF. One of the problematic dimensions of opening the front door concerns mobility. Therefore opening the front door can be linked to the activity walking (d450) of the ICF. Nevertheless problems can have more than one dimension and become a threat for several reasons; e.g. opening the front door poses, beside a mobility issue, the problem that it is difficult for the elderly to know if it is safe to open the door. Safety is not a specifically activity of an individual but more of the environment. Therefore two separate tables with results were created. The first table, Table 1.1, includes all the problematic activities mentioned related to section d of the ICF. The three right-hand columns show, per country, which activity was mentioned by which target group (please note that in the UK no focus group with elderly persons was conducted prior to this report). Activities mentioned after one of the target groups refer to one specific task within the ICF activity. The second table, Table 1.2, includes all the other outcomes that could not be grouped into the ICF for section d. As mentioned before a problem can concern more dimensions and therefore mentioned multiple times in the Table 1.1/1.2

Table 1.1. Overview of the difficult activities threatening the independence of the elderly mentioned during the focus group meetings, grouped into section d of the ICF. A. Elderly persons. B. Formal caregivers. C. Informal caregivers.

No.	Activity	ICF	The Netherlands	UK	France
1.	Reading	d166	C (reading medication instruction)		
2.	Managing daily routine	d2301		B	A, C
3.	Conversation	d350	A		
4.	Using communication devices and techniques	d360	B, C (for both using telephone)	B	A (using email), B, C (for all using telephone)
5.	Changing basic body position (e.g. sitting and getting up)	d410	B	B, C	B
6.	Bending	d4105	B		
7.	Lifting and carrying objects	d430	B, C (during shopping)		

8.	Fine hand use	d440	B (writing, handicrafts)	C	B, C (for both writing, handicrafts)
9.	Reaching	d4452	B		A, B
10.	Walking	d450	A, B, C	B, C	A, B, C
a.	Answering the front door		B		A, B, C
11.	Climbing	d4551	A, B	B, C	A, B, C
12.	Washing oneself	d510	A, B, C		A, B, C
13.	Caring for body parts	d520	B, C		A, B, C
14.	Toileting	d530	B, C	B, C	A, B, C
15.	Dressing	d540	A, B, C	B	A, B, C
a.	Putting on support stockings		B		A, B, C
b.	Changing bodily worn medical aids (e.g. changing catheter)		C		
16.	Eating	d550	B, C	B (forgetting to eat), C (eating well)	
a.	Opening bottles/cans		A, B, C		
17.	Drinking	d560			
a.	Opening bottles/cans		A, B, C		
18.	Shopping	d6200	B, C	C	A, B, C
19.	Preparing meals	d630	A, B, C	B	A, B, C
20.	Washing and drying clothes and garments	d6400	A, B, C		A, B, C
21.	Cleaning cooking area and utensils	d6401	A, B, C		A, B, C
22.	Cleaning living area	d6402	A, B, C		A, B, C
23.	Maintaining dwelling and furnishings	d6501			A (e.g. repair broken gate)
24.	Interpersonal interaction and relationships	d7	B (loneliness, solitude)	B, C	A, B, C (for all: solitude, isolation, loneliness)
25.	Basic economic transactions	d860	B	B	A, B, C
26.	Recreation and leisure	d920	B, C (for both reading books, watching television, handicrafts)	B, C	A, C

Table 1.2. Overview of other problems threatening the independence of elderly, mentioned during the focus group meetings that could not be grouped into section d of the ICF. A. Elderly persons. B. Formal caregivers. C. Informal caregivers.

No.	Problems		The Netherlands	UK	France
27.	Access to equipment				B, C
a.	In the kitchen (e.g. coffee machine, microwave)		A, C	B, C	
b.	In the living area (e.g. remote control, television, CD player)		A, B, C	B, C	
28.	Access to housing adaptations		B	C	A, B, C
29.	Access to services (e.g. home care)			B	B, C
30.	Access to technologies				B, C
31.	Accessibility to shops and other basic services			C	A
32.	Activation to do things			B	B, C
33.	Being dependent of others: needing to ask for help, giving up control, needing to wait for carer to get help		A	C	A, B, C
34.	Being dependent of technical aids		B		A, B, C
35.	Communication between carers		A		

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36.		Forgetfulness			
	a.	Taking medication	A, B, C		
	b.	Putting the light on/off	B		
37.		Monitoring: medicine intake, food intake, daily routine, daily activities	B		A, B, C
	a.	Fall detection			A, C
38.		Not wanting help, not recognizing the need for help		B, C	
39.		Receiving useful information about one's health and aids	A		A
40.		Relation carer – older person		B, C	B, C
41.		Safety/security			
	a.	Answering the front door	B		A, B, C
	b.	Being alone at night		C	A
	c.	Putting the light on/off	B		
42.		Poverty		B, C	A, B, C
43.		Visiting doctor	C	C	

To complete the problem assessment session in the focus groups, participants were asked to cluster and rank the problems. Problems that were often mentioned during the group session were not ranked as most problematic *per se*, as current solutions sometimes were found to be sufficient. One such example is the problem of preparing meals, which was mentioned multiple times in most focus group meetings. Current solutions (e.g. meal delivery services, microwave meals) meant that this problem was no longer perceived as a severe threat for the independence of elderly persons. The clustering and ranking of the problems resulted in eleven main problems, which are shown in Table 2. In this table an overview is given to the combined priorities over the three countries, specified per type of user. To further explain the problems indicated in Table 2, references are included to the more detailed activities mentioned in the Tables 1.1 and 1.2. Also here problems can be mentioned more than once as they can concern more than one dimension and may become a threat for several reasons.

Table 2. Overview of the highlighted (shaded) clustered problems expressed in the focus group meetings in the Netherlands, the UK, and France.

Problems	Numbers from Table 1.1 and/or Table 1.2	Elderly	Formal caregivers	Informal caregivers
Communication support for the hearing impaired	3 – 4 – 24			▨
Costs	42			▨
Housing adaptations	28 (+ mobility problems 5 – 11)	▨		
Isolation	24	▨	▨	▨
Lack of hobbies	26	▨	▨	▨
Mobility	5 – 6 – 9 – 10 – 11	▨		▨
Monitoring	37 – 37a (+ 10 – 16 – 17 – 36a)		▨	▨
Opening the front door	10a – 41a		▨	▨
Self-care activities	12 – 13 – 14 – 15 – 15a – 15b	▨	▨	▨
Shopping	7 – 9 – 18 – 31 – 36	▨		
Specific information about	39	▨		

health problems				

2.3 Conclusion

The goal of the focus groups was to find an answer to the following question: *Which problematic activities in daily life threaten the independence of elderly persons the most?* From this study is has become clear there is no single activity that can be selected as **the** activity causing a loss of independence. It is most often a combination of problems that leads to such a decision, based on the abilities of the person (patient) in relation to their own perception, their wishes and the environment of independent living (in social, physical and financial sense). Moreover this combination of problems differs between individuals leading to a diverse need for support to be asked from a robot system to be developed. For instance having mobility difficulties can lead to a range of problematic activities (e.g. dressing, doing groceries, cooking). However, persons not necessarily experience similar problems as also e.g. the housing condition (e.g. stairs/no stairs) and social condition (e.g. married, widow/widower) influence their abilities.

At the same time the combined user needs assessment does provide insight in the domain of activities in which problematic activities do occur. When a prioritisation of these activities is made on the basis of reporting by all three types of users included in the study, a list of most important fields of problems can be made. The most problematic activities identified by the combined focus group participants are shown in Table 3. In this table, reference is made to the more detailed activities underlying these problems as listed in tables 1.1 and 1.2.

Table 3. Overview of the main activities found in the focus groups meetings.

Priority	Problems	Numbers from Table 1.1 and/or Table 1.2	ICF	Description
1.	Self-care activities	12 – 13 – 14 – 15 – 15a – 15b	d5	When an elderly person is not able to take care of their personal hygiene, then he or she becomes dependent, especially when getting up in the morning or going to bed in the evening. Consequently, people have to adapt their daily schedule to the schedule of their caregiver. Self-care activities include washing oneself, caring for body parts, toileting, and dressing.
	Mobility	5 – 6 – 9 – 10 – 11	d4	Living independently at home becomes extremely difficult as one is not mobile any more. Mobility concerns the activities such as walking, climbing stairs, sitting & getting up, and bending. Mobility problems can also make other activities problematic (e.g. opening the front door or shopping).
	Isolation	24	d7	Isolation is caused by the decrease or even lack of activities concerning interpersonal interaction and relationships.

2.	Opening the front door	10a – 41a	-	This problematic activity consist of two sub-problems, namely mobility problems (e.g. not getting up/walking quick enough, which creates an unsafe situation) and safety problems (e.g. not knowing who is standing on the other side of the door). Most elderly persons are forbidden to answer the front door after dark by their informal caregiver.
	Lack of hobbies	26	d920	When ageing, persons experience physical problems. At a certain point people become unable to practice their hobby anymore (e.g. handcrafts or reading). This is problematic as elderly persons have no replacement when they cannot practice their hobby anymore.
	Communication support for the hearing impaired	3 – 4 – 24	-	The telephone is highly important for keeping in touch with friends and family, but hearing decline results in elderly people having trouble using the telephone. Also the lack of technical knowledge creates problems using the telephone, as elderly persons are not used to operating mobile phones or handling complex phones.
3.	Shopping	7 – 9 – 18 – 31 – 36	d6200	Problems around shopping are mainly because of physical limitations (e.g. inability to carry heavy bags, walk far distances, or inability to reach products in the store), but cognitive functions also sometimes play a role (e.g. unable to remember what to buy).
	Home adaptations	28 (+ mobility problems 5 – 11)	-	When home adaptations (e.g. support bars in the bathroom, toilet or stairs) are not sufficient, an elderly person is most likely unable to stay at home.
	Monitoring	37 – 37a (+ 10 – 16 – 17 – 36a)	-	Monitoring concerns medicine intake, food intake, (problematic) daily activities or fall detection.
	Specific information about health problems	39	-	There was a need to receive specific information about one own health problems and about ageing in general on a daily basis (e.g. when do you need to go to your doctor).
	Costs (e.g. poverty)	42	-	The costs and finance of equipment can be problematic as some elderly have no money for this.

It can be concluded that activities around mobility, self-care, and the lack of interpersonal interaction and relationships are seen as the most threatening for the independence of elderly by the participants from the focus group meetings.

- Self-care includes those activities mentioned in section d5 of the ICF. These activities are washing oneself, caring for body parts, toileting and dressing.
- Mobility concerns activities that can be found under section d4 of the ICF. This includes walking, sitting and getting up, bending, and climbing stairs.
- Lack of interpersonal interaction and relationships, mentioned in section d920 of the ICF. The lack of interpersonal interaction and relationships concerns isolation.

3 System Requirements

3.1 System functionalities in scenario building

3.1.1 Prioritised activities for Accompany

As explained in the Introduction section, the user needs assessment in Accompany consisted of several activities. The first part of this user needs assessment was reported in D1.1; an inventory of problematic activities in independent living from the literature and a description of care systems in four European countries. In section 2 of this report, the results of the focus groups were reported, providing an insight into the needs of the users. The user panels aimed for detailing the results reported in D1.1. Table 4 shows the fourteen high level tasks activities found in D1.1. The fourteen activities mentioned in this table correspond to the prioritised problems presented in Table 3 with the exception of *Home adaptation*, *Information on health problems* and *Costs (e.g. poverty)*. These three problems of Table 3 are not activities but more general problems. But when the prioritisation on *Mobility*, *Self-care* and *Isolation* found in chapter 2 is crossed with the activities derived from D1.1 three activities could be deleted from the list and 11 activities remain (as shown by Table 4).

3.1.2 General system capabilities

Given the observation that there is no single activity that can be selected as **the** activity causing loss of independence, a strategy aimed at solving the most important problems is the logical option. Therefore it was tried to distil a list of capabilities of a supporting system that would enable the system to support many problematic activities.

To do this, next to the list of the remaining 11 activities in Table 4, general components (building blocks) of each of these tasks can be found. A general component (building block) is an element of an activity that needs to be performed in order to successfully perform the activity; e.g. getting dressed exists out the general components (building blocks) monitoring, selecting clothes, and (un)dressing. A system (service robot) that would be able to support these components (building blocks) could have the potential to solve several problems rather than one specified activity. A capability of the robot in one task could be transferred to other tasks (from the bathroom to the kitchen). This could well be a crucial capability of the robot if it is to be made effective in supporting elderly at home.

Table 4. The fourteen activities mentioned in D1.1.

		High level tasks	ICF	Building blocks				
Mobility	1.	Changing basic body position (e.g. sitting and getting up)	d410	Monitoring	Transferring			
	2.	Bending	d4105	Monitoring	Transferring			
	3.	Lifting and carrying objects	d430	Monitoring	Recognising	Fetch and carry	Presenting	
	4.	Reaching	d4452	Monitoring	Recognising	Fetch and carry	Presenting	
	5.	Walking	d450	Monitoring	Transferring	Moving	Transferring	
		Climbing	d4551					
Self-care	6.	Washing oneself	d510	Monitoring	Undressing	Washing	Drying	Dressing
	7.	Toileting	d530	Monitoring	Transferring	Undressing		
	8.	Dressing	d540	Monitoring	Selecting clothing	(Un)dressing		
	9.	Eating & drinking	d550 d560	Monitoring	Fetch and carry	Presenting		
		~~Shopping~~	~~d6200~~					
		~~Preparing meals~~	~~d630~~					
		~~Household activities~~	~~d6400~~ ~~d6401~~ ~~d6402~~					
Social isolation	10.	Interpersonal interaction and relationships	d7	Monitoring	Fetch and carry	Offering interface (remote control)		
		Recreation and leisure	d920					
	11.	Access to equipment (e.g. telephone)	e115	Monitoring	Offering interface (remote control)			

3.1.3   Target groups

The problem with the activities in Table 4 is that, if it is translated into concrete scenarios it could lead to completely different supporting activities depending on the users involved. One user may need just a little balancing support while standing, while another may need intensive support and being dressed in the absence of a hand function. Therefore the second step we propose is a first distinction between types of users. As example three types of users are described here, but of course these are still very general descriptions that need more detailing. But these three users can help in guiding the scenario description at this stage.

User 1
User is older and lives at home alone, is still able to perform most tasks but is frail and needs support (an arm when walking, a third hand for stability and sense of safety when performing physical tasks). The user is getting somewhat forgetful. Seeks light support in many tasks to remain independent.

User 2
User is older and severely disabled. Wants to remain in own home but needs extensive support in many ADL activities. The support system must carry out tasks and provide mobility. User needs to be fed, needs to be washed, needs to be clothed and uses a wheelchair for support.

User 3
User is older, recovering from surgery (e.g. hip replacement) and wants to return to home but is still under rehabilitation treatment. The user needs support in day to day activities but wants to be self-supporting again as soon as possible. This could be supported by a system that assesses user's physical ability and offers support on demand, and motivation to keep practicing.

The Accompany project is placed around the definition of the first user, who is independent but at risk of losing his/her independence. With an eye on the duration of the project and the capabilities of the Care-O-bot, realization of tasks for this type of users is deemed as feasible. Support for user 2 is not feasible, while assisting user 3 (rehabilitation and complete re-ablement) is similar to user 1 but requires increasingly smart systems to be able to adequately support the rehabilitation process of the users. It is notable that rehabilitation robots have grown in number since 1980s, yet there are currently no commonly acceptable platforms or active intervention with clear gains for different user groups[1]. Elements of re-ablement can also be incorporated in needs of user group 1.

Furthermore, when looking more closely at the decompositions of the tasks in Table 4 and categorising the general components mentioned, five basic ingredients/building blocks within the required functionality (for user 1) can be found:

- **Initiating** an activity
- **Monitoring** the state of the user and the progress of the activity

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[1] For example see: Lo, A. C., P. D. Guarino, et al. (2010). "Robot-assisted therapy for long-term upper-limb impairment after stroke." N Engl J Med **362**(19): 1772-1783.

- **Supporting the balance** of the user (either standing or walking)
- **Supporting transfer** of the user (e.g. from bed to the chair next to the bed)
- **Fetch and carry** of objects

It is important to realise that these are NOT sequential steps but may coincide, alternate or repeat in many different orders during task execution. These building blocks may occur in each of the ten activities of Table 4, but they have different meanings and execution modality depending on the context of activity. This leads to Table 5. In this table 11 columns, containing the 11 tasks within the 3 prioritised problems for user type 1, are explained in how the building blocks are utilised. For the Accompany project the scenarios could be built from each of these 10 columns or several columns together. Scenarios within these columns are as far as the user needs are concerned in line with the assessment carried out and reported in D1.1 and section 2 in this report.

Table 5. Detailing the systems' building blocks for each of the problematic activities.

Building blocks	Mobility						Self care				Social Isolation	
	1.	2.	3.	4.	5.		6.	7.	8.	9.	10.	11.
	Getting in/out of bed	Bending	Lifting and carrying objects	Reaching	Walking	Falling	Washing oneself	Toileting	Dressing	Eating & drinking	Social contact & recreation	Access to equipment
Initiating	Is it time to get up/go to bed?				Need for activity/time to go?	What type of help is needed?	Is there a need for a washing?	Need to go? When scheduled	Is it time to get dressed?	Is it time to eat/drink?	Social appointment?	Someone is calling
Monitoring			Need for lifting/ carrying object?	Need for object, placed high/low?	Navigating	Fall incident?		Is user forgetting?	What clothes to wear?	Is the user forgetting?	Lonely, bored	Recognise question, external initiation
Supporting balance	Support user while getting in/out of bed	Support user while bending		Support user while reaching	Support user while walking	Bringing user to safe position	Support user while performing activity	Support user while dressing and cleaning	Support user while getting dressed			
Supporting transfer	Dynamic support from lying to standing	Help user bending/ getting up		Help user reaching	Getting up/sitting down	Help user getting up		Helping on/off toilet				
Fetch & carry			Carry object	Grap/carry object	Carry luggage	Offer communication for help	Offer towel, soap, etc.		Get clothing/put clothing away	Bring drink/food	Bring item or present interface, offer activity (e.g. game, song)	Present interface, bring device, operate device

Building Blocks	WP2 (UNISI)	WP3 (UH)**	WP4 (UVA)	WP5 (Fraunhofer)
Initiating	*Keep track of patterns in offered functions (fetch and carry) in order to initiate 'conversation'.* Recognize context based on location, time of day → Let COB listen and Look at source (Looking together to the same source, e.g. TV, would create an empathic feeling. This is a joint-adventure.)	Walking → *Robot monitors uninterrupted time spent at sofa.* Robot encourages the user to exercise Eating & Drinking → *Robot monitors when user last had a drink.* Robot initiates a drink activity after a certain period of time. Shopping → *Robot maintains in its memory a list of grocery items.* Remind user when running low.	- User comes into a room and is detected as a moving object immediately. As the robot is not sure who is coming, the robot turns gently to the user, say greetings and identifies the user from his face, appearance, voice, etc. - If the robot does not recognize the user (e.g. a new user), the robot asks for the name of the user in a friendly way and stores the appearance characteristics of the new user. - The accurate location of the robot is estimated by data fusion of the robot sensors and ambient camera. - The robot starts offering help based on its memory (WP3)	Detection/identification *: Have some kind of social behavior, e.g. on the first recognition of the user in the morning, let the robot say "good morning", or address recognized persons always by their name, etc.* Greet owner
				Recognition/categorization: *Robot offers services related to the occurrence of certain objects.* Recognize remote control → Knowing that the user is currently engaged with the remote control for the TV the robot could suggest to communicate the current TV program (or suggest something interesting) and could offer to watch TV with the person (this also involves human skeleton detection and user interface).
Monitoring	*Monitor elderly whether having trouble or not with things.* Understand elderly needs defined by use in context → Person laying, trying to reach, trying to stand up etc. Monitoring of objects is required for fetch & carry)	Operating equipment → *Robot goes to the location where bottled water is stored and then fetches it for the user* Shopping → *Robot maintains in its memory a list of grocery items.* Remind user when running low.	- Using the camera mounted on the ceiling, the system tracks the person and keeps reporting location of the person to the robot. - When the target gets lost in the ceiling mounted camera (e.g. occluded by the door), the robot finds the user and re-locates the user with sensors on board.	Detection/identification *: Monitoring how much the person is drinking along the day and reminding to drink or offering drinks (this also involves initiating and fetch & carry).* Be able to fetch drinks for the user (includes object detection)
	Monitoring behavior. Squeezing to get attention from the COB (Initiate a conversation coloured with expression based on the elderly's	Medication (drinking) → *Monitoring when the user last had a drink.* Robot reminds user to drink water.		Detection/identification *: Remember places where the user left some important object (e.g. keys, glasses, etc.)*

	input. A soft squeeze will make the COB attend gently while a harsh pinch makes the robot rush to help out.) <u>Monitoring of objects is required for fetch & carry)</u>	Recreation/Social → *Robot monitors the status of the TV and the user's location.* Robot joins user and pretends they are "watching TV together" (similar to a dog or cat "watching TV with us").		Recognize a few know objects. Maybe already store their positions in a map whenever the objects are seen. <u>Could be connected with objet tracking from UVA to cover cases when somebody moves an object.</u>
				Detection/identification *: Operating equipment (e.g. ringing cell phone).* Recognize the respective item of equipment and be able grasp it.
Supporting Balance	*			***
Supporting Transfer	*		When the user walks heading to the toilet, the system analyzes the track of the user and turns on the light in the toilet.	***
Fetch and Carry	*Get eatables and other items for the elderly.* Enable elderly to select action possibilities with objects known.	Object manipulation →*Robot fetches bottled water for the user in a socially acceptable manner.*	The robot knows the location of the user and the layout of the room. When asked for getting a cup of coffee, the robot decides which location is the best for interaction with the user.	Detection/identification *: Recognize the user who ordered an object within a group of several people.* The main user and a guest are sitting on the couch. COB knows both's faces and remembers who ordered something to deliver it to the right person →This can be done with person tracking <u>UVA</u>) but if person tracking fails face identification can resolve the problem. Important: the user must face COB's cameras at order and delivery time.

	Empathy layer in the way of moving. Independent of what the robot is doing, the way of moving should be adjusted to the elderly's input.	Medication (drinking) → *Monitoring when the user last had a drink.* Robot reminds user to drink water.	Detection/identification *: Personalize the behavior for the respective user, e.g. interaction distance or preferred mode of interaction.* User identification should work for a set of 2-3 know users <u>This task must be done in conjunction of WP2 and WP3 who can use the person identification information</u> Detection/identification *: Get drinks ad food (or other larger objects) for the user.* Recognize a few known objects and their pose and grasp them.

*Left out as Fraunhofer indicated these as infeasible within the scope of the project.

**Re-ablement (WP3), co-learning (WP3), empathic behaviour (WP2), socially acceptable behaviour (WP2), attention seeking (WP2), preferences (WP3), sensory networks (WP4)

*** This task will be likely impossible within the scope of the project and given the COB

4   Project scenario

4.1 Initial scenario

On the basis of the analysis of user requirements and system requirements, reported in the previous chapters an initial scenario is formulated containing functionalities that are both considered required from user perspective and at the same time feasible at this stage of the project.

The building blocks are used to determine the feasibility of developing a system that could provide a solution to one of the problems that resulted from the user needs within the domains, social isolation, mobility and self-care. It is clear that a choice has to be made in the formulation of a scenario because providing a solution for all the problems is simply not possible within the context of the Accompany project. Nevertheless it is clear that all the listed problems are relevant and when not solved in this project, solving the problems should be put on a wish list for robot development in the future.

The developed scenario contains three out of the five building blocks:

1. *Initiating*: when the robot notices the user has not drunk enough, it reminds the user to have a drink.
2. *Monitoring*: the robot monitors when the user eats and/or drinks something.
3. *Fetch and carry*: the robot brings a bottle of water to the user.

The building blocks *Supporting balance* and *Supporting transfer* are not present in this scenario as both were indicated as infeasible within the scope of the project by Fraunhofer for the reason that these require human-robot contact which is not possible yet. It is a pity that the robot cannot perform human-related activities, as this is something we would certainly like to have as it would enhance the independence of elderly persons. But because it is not feasible for now we will first focus on object related tasks as these are safer to start with.

This scenario matches the domains *Self-care* and *Mobility* of the User Requirements. Mobility can cause many problems, from which getting up and walking to the kitchen to get a glass of water is only one activity. Also drinking is only a small part of the domain self-care. Nevertheless it is important to know that this is only the starting point, which we will deepen the upcoming years. The domain *Social isolation* is not explicitly present in this scenario. This domain not necessarily required a robot, however activities concerning this domain can be implemented during the upcoming years.

<Deliverable 2.1>

"User sits on the sofa in the living room and watches TV/reads. The robot has noticed that she has been sitting there for 2 hours and hasn't had anything to drink for a while (in fact for 5 hours). It approaches her in a friendly/un-intrusive manner with slow/gentle movements/trajectories, adopting an appropriate social interaction distance, produces appropriate attention seeking behaviour - according to previously learnt user-preferences. The robot waits for the user to turn towards the robot. The robot then reminds the user of having something to drink and offers to fetch a drink from the kitchen. The user confirms via the 'interface'. The robot then uses learnt information on the user's drink preferences, goes into the kitchen, picks up a small bottle of water, brings it to the user, waits in front of the user in waiting position until the user indicates through the interface to place the bottle on the table. The robot puts the bottle down, says "You are welcome". The robot then suggests "Would you prefer if I would bring a large bottle next time, so that you drink whenever you like?" The user confirms and enters water on the shopping list. After completing the tasks the robot adopts an "empathic" position (next the user, pretending to "watch TV"), shifting position in synchronisation with the user."

The above contains: personalisation/memory/planning (WP3), interface/empathic-expressive behaviour (WP2), activity recognition (WP4), re-ablement (leave a big bottle of water on the table which makes it easier to remember to drink), co-learning (both learning about the next order/ shopping). The scenario is also feasible and elements of it could be shown at the first review, with increasingly more complex elements to be added as the project progresses.

4.2 Phase one scenario derived for year 1

An iterative development of components, while the project progresses, will be realised as a series of sub-scenarios in line with the project scenario. The first iteration, phase one scenario, entails the project achievement in its first year, demonstrating S&T activities under different work packages of the project which will come together under the first project prototype which will be used for formative and summative evaluations by WP1 and WP6. The phase one scenario has a narrower scope than the project scenario due to the short time that is available between the user and system requirements elicitation and the delivery of D1.3 at project month 12. Thus the phase one scenario is defined as follows:

"After the user enters the room, the Accompany system localises the user (WP4, task 4.1). The robot greets the user with a good morning or good afternoon (WP5, task 5.2 for adaptation). The user sits on the sofa in the living room (WP3, detected by sofa sensors) and picks up the user interface. The context aware planner, based on the user's identified location on the sofa, has enabled a set of functions such as offering TV programs, and reminder functions – based on previous activities with the user (WP2, task 2.4). The user can select among these functions, and the robot will respond accordingly. Alternatively, the user may squeeze the interface and the robot approaches the user

(location acquired from task 4.1), adopting a speed according to the squeezing force recorded by the interface (WP2, task 2.1 user interface design)."

As annotated within the phase one scenario, different components of the scenario are due to developments in different work packages. The role of WP5, task 5.2 is to allow for easy integration of these developments into a coherent scenario as explained above.

4.3 Iterative cycle of scenarios to achieve project scenario

During the progress of the project, more complex functionalities will be added to phase one scenario to form phase two and complete project scenarios. For now it is impossible tell more about the next steps as future user panels will guide the development of the scenario. Based on the outcomes of the focus group meetings complex functionalities will be added to the robot. Task 1.4 is dedicated to this iterative detailing of the scenarios, which enables the flow and implementation of the results from formative cycles (focus group meetings) into next iteration of the scenarios.

For this project activities concerning *Self-care* and *Mobility* combined with the building blocks *Initiating*, *Monitoring,* and *Fetch & carry* are seen as the main direction. As a starting point the above scenario "bringing water to the user" was selected. From there more complexity will be added throughout the project, also the use of the developed functionality for solving other problems will be considered.

References

1. World Health Organization (2002). Towards a Common Language for Functioning, Disability and Health: The International Classification of Functioning, Disability and Health. Retrieved January, 13, 2012, from
    http://www.who.int/classifications/icf/training/icfbeginnersguide.pdf