DELIVERABLE 1.3

Phase one scenarios and report on system functionality

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Short description

Phase one scenarios and report on system functionality: This deliverable reports on the first outcome of task T1.4.

Table of Contents

Introduction

This document is the third deliverable in the user needs work package WP1 (see Figure 1) and follows D1.1: *Status of elderly care in Europe and the potential for service robotics* and D1.2: *Report on user and system requirements and first outline of system functionality*. 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 (e.g. the Netherlands, Italy, UK and France). In D1.2 we specified 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) which led to an initial scenario for the Accompany robot development.

D1.3 reports on the first outcome of the iterative detailing of the scenario. The result of this deliverable is the phase one scenario, set in the perspective of three sub-scenarios leading to an end state scenario for the Accompany robot system supporting elderly maintaining their independence in their home situation. The development of this phase one scenario (by Work Packages 2, 3, 4 and its successful integration under WP5) will be the target for the initial development of the robot system in the Accompany project.

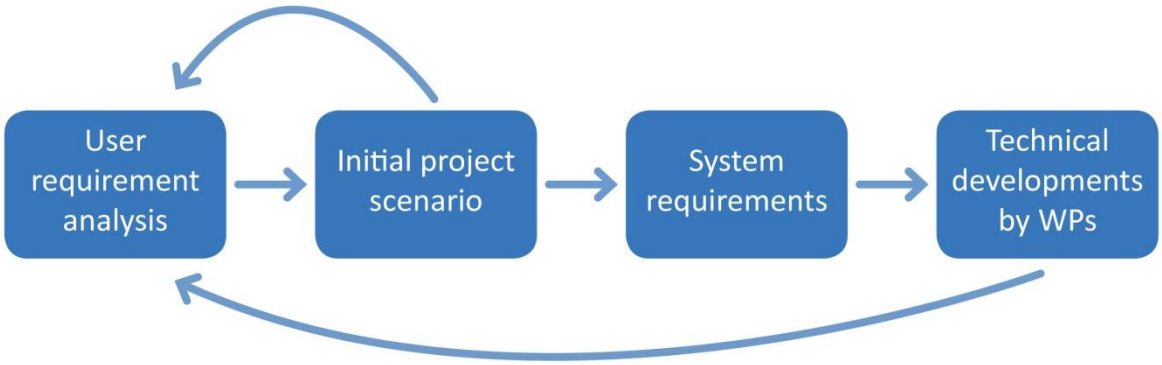


Figure 1. Progress in WP1 from user requirement elicitation to scenario definition and formulation of system requirements.

Chapter 1 of this deliverable reports an outline of the results of the first round of focus groups and initial scenario as earlier presented in D1.2. In the second chapter the results of the second round of focus groups, concerning the feedback on the initial scenario presented in D1.2 (see Figure 2), will be presented. In chapter 3 the phase one scenario will be described followed by the system functionalities.

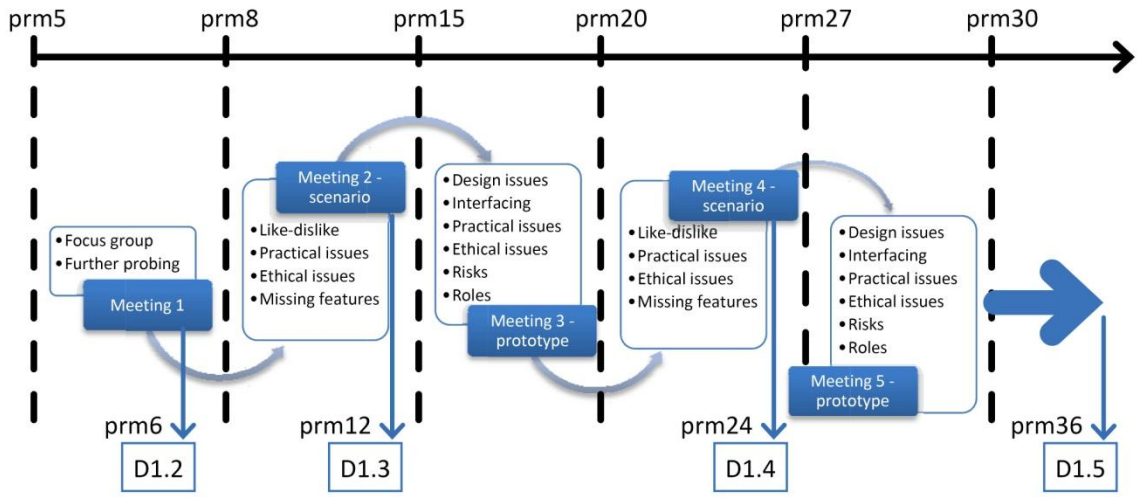


Figure 2. Plan of focus group meetings as the project progresses.

1 User needs

This chapter describes the results of the inventory made on the nature of the problems elderly have in maintaining their independence in staying at home. This chapter presents the results of a literature study and the results of focus group sessions conducted with elderly persons, formal caregivers, and informal caregivers in the Netherlands, the UK, and France, surveying the needs of future users. This survey process was guided by the following question: *Which problematic activities in daily life are most threatening for the independence of elderly persons?* From here the step is made to the system functionalities and the initial scenario. The aim of the first round of participatory groups was to qualitatively investigate the nature of the problems elderly people face in trying to remain living independently. To better understand these problems not only elderly people, but also informal and formal caregivers were included in the focus group sessions. The initial scenario was used during the second round of focus groups.

1.1 Introduction

In western society adults tend to live independently in their own homes. Individuals act upon their preferences regarding independent living, adapting to their changing preferences over time. As people age, citizens are faced with the negative consequences of decreasing ability which, among other factors, threaten independent living. Age-related changes in mental and physical abilities can make the performance of everyday tasks difficult or challenging. For those who are not able to maintain their independence, different societies seek different kinds of solutions towards regaining or sustaining independence, or alternatively offer an institutional arrangement for dependent living.

Regardless of the housing setting, traditionally, care is provided either informally by those from the direct social environment (e.g. family) or more formally by professionals funded by either public or private means. However, social structures have changed, which have resulted in family members being less inclined and/or able to provide care. Due to this change and the increasing shortage of care staff (Cameron & Moss, 2007) alternative solutions are being given increasing attention, with technology as the alternative with the highest potential. Of course, technology is already being used to support independence. Assistive technology (AT), such as wheelchairs, stairlifts, patient hoists, smart home technologies and in general accessibility adaptations of the home have come a long way in supporting individuals in their independence (Vlaskamp, Soede, & Gelderblom, 2011). But with the ongoing development of technology new possibilities emerge for supporting independent living. A new emerging field in AT is robotics. Robotics has the potential to support care and independence in many ways (Bekey et al., 2006). Although there is still only limited application of robotics in care, substantial effort is being taken to develop applications (Butter et al., 2008). The envisioned role of the robots in these developments, and the type of tasks the robots perform, are primarily guided by technical feasibility and to a lesser degree by the target users' needs (Butter et al., 2008). Over the past decades hundreds of projects have developed a range of functionalities. Nevertheless, only a small

number of robot systems have actually been brought to the market and made available to support care for individuals in their daily lives. In the FP7 European ACCOMPANY project an existing service robot's functionality will be further developed to support older citizens to sustain independent living (Acceptable robotics COMPanions for AgeiNg Years, n.d.). The first goal of the ACCOMPANY project is to understand the needs of future users, regardless of technological considerations.

1.2 Literature

Humans perform a very wide range of activities, any of which could potentially become difficult for older people to perform, thereby threatening independent living. To deal with the variety of pertinent activities, the International Classification of Functioning (ICF) of the World Health Organization (WHO) was adopted to group the outcomes in this study. The ICF provides a structured taxonomy for the description of human functioning (World Health Organization, 2002). Within the ICF only the subgroups of section d, *Activities and Participation*, was considered to be relevant as the focus here is on the activities people perform and not on their abilities (e.g. loss of eyesight is a loss of an ability, but as a consequence of loss of eyesight people may have difficulties with a wide range of activities from walking stairs to reading). Also the type of robot pursued in Accompany aims to support activities and is not aimed at replacing lost or declined human abilities.

In the literature and through personal communications several publications were found that focussed purely on problematic activities threatening the independence of elderly people and simultaneously also involved elderly persons in the study. Furthermore, the process for user driven selection of care or service tasks in robotics projects supporting independently living elderly persons is not well documented. Only a limited number of publications and public documents on user needs driven functionality selection without *a priori* filtering for intended technical functionality could be found through the CORDIS website (Community Research and Development Information Service, n.d.). This is surprising, given the vast amount of funding invested in robot development in the last decade, indicating that, different from Accompany, many such projects are strongly technology driven.

The European Multi-Role Shadow Robotic System for Independent Living (SRS) project (Facal et al., 2011), together with the Dutch study into *The most recurrent problems of the independently living elderly: recommended assistive devices and solutions*[1] (Crützen et al., 2010) both produced a list of activities that make independent living challenging for elderly persons. In the European SRS project the difficulties of elderly persons could be assigned to three categories; 1) psychological difficulties, 2) health problems, and 3) difficult daily tasks (Mast et al., 2010). The Dutch study by Crützen *et al.* resulted in a top ten list of difficulties concerning daily tasks. A highly prioritized psychological difficulty identified in the SRS project, which fits section d of the ICF, was loneliness. Loneliness was found to be the result

[1] Translated from the original Dutch title

of the reduction in social relationships (d7). Other highly prioritized psychological difficulties were the lack of autonomy (dependence on caregivers) and fear of falling. The most highly prioritized health problems were a decrease in overall energy (muscle strength, endurance, speed), decreased hearing ability and eyesight, and forgetfulness (e.g. regarding taking medicine). Prioritized difficulties with daily tasks, mentioned in both studies, were mobility-related ones (walking – d450, climbing up stairs/into bath tub – d4551, reaching for objects – d4452, sitting and getting up – d410), housework (vacuuming and cleaning bathroom/toilet – d6402, carrying water – d430), preparing food (d630), shopping (especially carrying heavy shopping bags – d6200, d430), and putting on clothes (d540). This list of daily difficulties is also confirmed by the results of a literature review on how robots can support older adults' independence by assisting with difficult tasks in the home environment (Smarr, Fausset, & Rogers, 2011). This literature review also found that leisure activities (d920) can be difficult or frustrating for elderly people due to limited physical ability or limited technological knowledge. Out of the six ADLs (i.e. bathing/showering, dressing, eating, getting in/out of bed/chairs, walking, and using the toilet) non-institutionalised elderly persons experience limitations mostly with walking, bathing/showering and getting in/out of bed/chair (Administration on Ageing, 2010). Apart from these six ADLs, there are many everyday tasks persons need to be able to perform to maintain their independence.

A total of twenty-two activities were collected from the literature (see Figure 3). Eighteen of these activities could be grouped into section d, *Activities and Participation*, of the ICF. Three of the four remaining activities were excluded as these were problems and not actual activities (e.g. decrease in overall energy). The fourth remaining activity: access to equipment + using communication devices, could be grouped into section e, *Environmental factor,* of the ICF as well. The nineteen activities left were clustered and resulted in the overview given in Table 1.

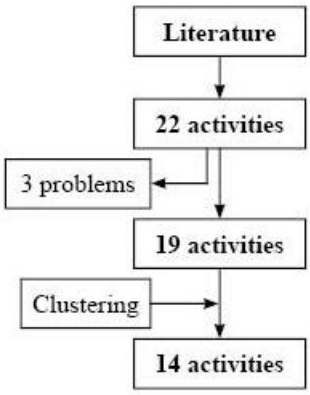


Figure 3. Steps taken in the analysis of the literature.results.

Table 1. Overview of activities identified in the literature threatening independent living of elderly persons.

No.	Activity	ICF
1.	Changing basic body position (e.g. sitting and getting up)	d410
2.	Bending	d4105
3.	Lifting and carrying objects	d430
4.	Reaching	d4452
5.	Walking	d450
	Climbing	d4551
6.	Washing oneself	d510

7.	Toileting	d530
8.	Dressing	d540
9.	Eating	d550
	Drinking	d560
10.	Shopping	d6200
11.	Preparing meals	d630
12.	Washing and drying clothes and garments	d6400
	Cleaning cooking area and utensils	d6401
	Cleaning living area	d6402
13.	Interpersonal interaction and relationships	d7
	Recreation and leisure	d920
14.	Access to equipment + using communication devices	e115 + d360

After the submission of D1.2 the results of this literature review have been extended and will be submitted as journal article.

1.3 Focus Groups I

1.3.1 Method

Different focus group meetings were held in the Netherlands, UK, and France. For the data collection the Metaplan method was used (Metaplan GmbH, n.d.). This method first identifies viewpoints of individual participants and then seeks group consensus. The Metaplan method is 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.

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) 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 aim of this focus group would not be on the use of robots.

In total 113 persons participated in the study:

- Forty-one elderly persons (12 male, 29 female) with a mean age of 78.0 years (60 to 95) participated in focus group meetings in the Netherlands (11), UK (5) and France (25). All elderly persons were still living at home and receiving some form of care assistance (e.g. home care, Care TV)
- Forty professional caregivers (2 male, 38 female) participated in focus group meetings in the Netherlands (14), UK (4) and France (22). Caregivers' professions ranged from care workers, nurses and psychologists to managers. All professional caregivers worked closely with the 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.

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 as 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 the wall 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 encouraged 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. 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 answer 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.

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 compiled, 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.

1.3.2 Results

From the focus group meetings a total of forty-three different problems were gathered (see Figure 4). Similar to the literature results, 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. The other types of problems mentioned are not specifically activities of individuals but more of the environment (e.g. being looked after). To complete the problem assessment session in the focus group meetings, participants were asked to cluster and rank the problems.

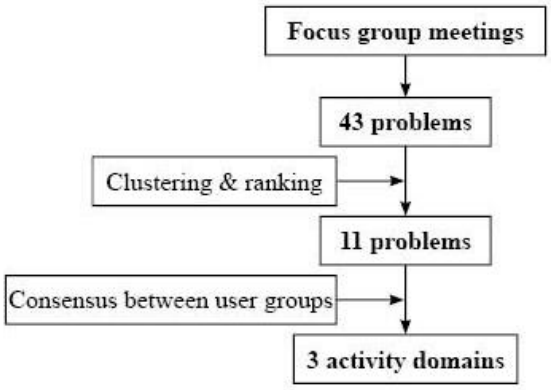


Figure 4. Steps taken for the analysis of the results of the focus groups.

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. Problems can become multi-dimensional as a problem may become a threat for several reasons; e.g. opening the front door presents a mobility issue, but also poses the problem that it is difficult for the elderly to know if it is safe to open the door. Table 2 also visualises the consensus between the three different groups. Following this consensus a priority list could be created. Table 3 shows the three activities (i.e. self-care activities, mobility activities, and isolation) that were given the highest priority, as they were seen as most threatening for the independence of elderly by participants from all the three target groups.

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

No.	Problems	Elderly	Formal caregivers	Informal caregivers
1.	Communication support for the hearing impaired			
2.	Costs (e.g. poverty)			
3.	Housing adaptations			
4.	Isolation			
5.	Lack of hobbies			
6.	Mobility			
7.	Monitoring			
8.	Opening the front door			
9.	Self-care activities			
10.	Shopping			
11.	Specific information about health problems			

Table 3. Overview of the three activity domains that were given the highest priority by participants of all three target groups

No.	Problems	ICF	Description
1.	Self-care activities	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.
2.	Mobility	d4	Living independently at home becomes extremely difficult as one is not mobile any more. Mobility concerns 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).
3.	Isolation	d7	Isolation is caused by the decrease or even lack of activities concerning interpersonal interaction and relationships.

1.4 Results

The next step was to combine the results of the literature with the results of the focus group meetings. Therefore we analysed which of the fourteen activities derived from the literature (Table 1) corresponded with the three highlighted activity domains of the focus group meetings presented in Table 3 (see Figure 5). Combining these items resulted in eleven activities shown in Table 4. Three of the fourteen activities of the literature (i.e. shopping, preparing meals, and household activities) were present in the first list with the forty-three problems derived from the focus group meetings, but were not ranked as most problematic and therefore no longer included in the list given in Table 2.

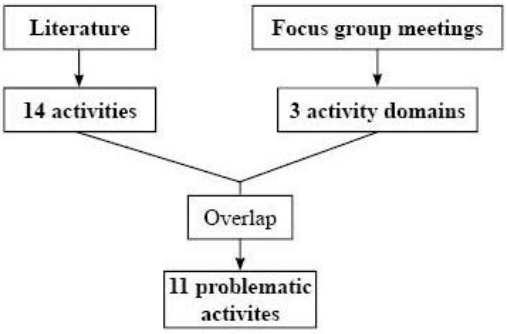


Figure 5. Steps made combining the results of the literature and focus group meetings.

Table 4. Combined results of the literature review and focus groups.

	No.	Activity	ICF
Mobility	**1.**	Changing basic body position (e.g. sitting and getting up)	d410
	2.	Bending	d4105
	3.	Lifting and carrying objects	d430
	4.	Reaching	d4452
	5.	Walking	d450
		Climbing	d4551
Self-care	**6.**	Washing oneself	d510
	7.	Toileting	d530
	8.	Dressing	d540
	9.	Eating	d550
		Drinking	d560
Social isolation	**10.**	Interpersonal interaction and relationships	d7
		Recreation and leisure	d920
	11.	Access to equipment + using communication devices	e115 + d360

1.5 Conclusion

This goal of these first focus groups was to find an answer to the following question: *Which problematic activities in daily life most threaten the independence of elderly persons?* From this study is has become clear there is no single activity that can be selected as **the** activity

causing a loss of independence. This is understandable in light of the diversity in age related loss of abilities between individuals and the diversity in living environments between individuals. Activities concerning mobility (d4), self-care activities (d5), and social isolation (d7, d920, and e115 + d360) are seen by elderly persons, formal caregivers, and informal caregivers as the most problematic and that threaten the independence of elderly persons. The results of the literature and the focus group meetings show significant overlap. The main outcomes are similar and therefore strengthen each other. This confirms the relevance of the reported most problematic activities. The fact that these activities are highlighted here does not automatically lead to the conclusion that this is the target list for robot development. Robotics as a solution to any of these problems offers certain capabilities which may or may not be suitable for exploitation as assistive devices to support elderly at home. There may be other technological solutions that are to be preferred in seeking a solution for specific activity related problems (e.g. ICT technology) and there may be tasks for which human support is preferred on the basis of cultural or ethical considerations. For the purpose of the Accompany project the first two identified domains (mobility and self care) were seen as the most appealing for developing a robot solution. For the third domain, social inclusion, many ICT based solutions are already available or are under development.

In France an additional element was executed in all focus group session: after completing the session as described in the chapter 1.3.1 a sociological evaluation was conducted in which the use of a service robot for elderly persons was openly discussed. This discussions lead to six different user profiles. According to the French participants in this sociological evaluation, the robot should be offered to:

1. People that are still very independent and who do not ask for a carer but simply someone to help with household tasks: *"There are people who consider that as they are paying, the professionals are there to do things for them. They have somewhat of a consumer attitude, given that they are capable of doing something but do not want to. Given that they do not really need any help, a robot could be of more use to them one of the professionals."* – head of a professional care service
2. Very dependent elderly, as a complement to the aids and healthcare already provided: *"The robot could be of use for very dependent elderly who are socially isolated, and who have need of a high level of surveillance. The robot would be linked to either the family, or a service provider. The robot would transmit all necessary information: it could provide a summary of the varied interventions, of the needs, and it could also send alerts if needed, for example in the event of a fall."* – head of a professional care service
3. Elderly living alone, but who are not socially isolated: *"The robot could be useful for security for when someone is alone, but it should not be used to provide emotional needs."* – elderly person
4. People who are temporarily invalidated: *"There are people who have a leg in plaster after an accident, or who return to their home after being hospitalised. The person is going to recover their independence progressively. If they receive too much help and let the carers do everything for them, they run the risk of becoming dependent and might only recover partial independence. In addition, they might also end up becoming depressed. For such people it might be worth trying to stimulate them, and a robot might enable them to recover their independence quicker."* – head of a professional
5. Highly independent people who do not accept having someone present in their home: *"It might be easier for some people to accept the presence of a robot, rather than accepting us."* – social worker
6. Families who are too far away to be present daily, but who would like to keep an eye on their parents: *"Sometimes families ask us to intervene but it is more for security reasons than to provide care. The fact of sending someone means that they will perform tasks that the elderly person is capable of doing themselves, something that will not help maintain independence. If the robot enables such people to stay in their own homes and for their families to be reassured, then why not?"* – Head of a professional care service

From these six user profiles a translation to three different user types has been made, namely:

1. Users requiring mild support: This user is older, lives at home alone and 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 and seeks light support in many tasks to remain independent – Related to user profiles 1, 3, 5 and 6.
2. Users requiring intensive support: This user is older and severely disabled. He/she wants to remain in his/her 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 – Related to user profiles 2
3. Users requiring temporarily support: This 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. – Related to user profile 4

The decision was made to place the Accompany project in the first instance around user type 1: this user 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 more complex and, when looking at the extensive support this user needs in many ADL activities (e.g. user needs to be fed, needs to be washed, needs to be clothed), 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.

From the six user profiles of the sociological evaluation also the step towards possible robot roles has been explored. This resulted in three possible robot roles:

1. Assistive device/butler role: In this role the robot executes the whole activity alone. It acts like a servant and obeys the user – Related to user profile 1, 3 and 5
2. Re-ablement coach: This role intends to improve the capabilities of the user so he/she can finally perform the tasks ideally alone again – Related to user profile 4
3. Co-learner: In this role the robot only support (problematic) activities partly. The robot learns from the user which part of an activity it should support and in which manner – Related to user profile 2 and 6

The co-learner and re-ablement coach are more complex version of the assistive device/butler role. In these two roles the robot does not automatically obey all orders of the user. The re-ablement role and the co-learner may overlap in their effective behaviour. The difference between the two lies in the aim of these roles in supporting independence. The re-ablement coach intends to improve the capabilities of the user so he/she can finally perform the tasks ideally alone again, while the co-learner role is more focussed on the robot adjusting to the personal (and changing) preferences of the user.

1.6 Initial scenario

The target user group of the Accompany project consist of elderly people living independently but at risk of losing his/her independence. With an eye on the short duration of the project and the capabilities of the Care-o-bot, realization of tasks for this type of users is deemed as feasible. 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 in D1.2 to distil a list of capabilities of a supporting system that would enable it to support many problematic activities. This resulted in five basic ingredients/building blocks within the required functionality (for the given user). With these five capabilities is some solution conceivable for the 11 gathered activities (see Table 4) that could threaten independent living when no longer possible:

1. **Initiating** an activity
2. **Monitoring** the state of the user and the progress of the activity
3. **Supporting the balance** of the user (either standing or walking)
4. **Supporting transfer** of the user (e.g. from bed to the chair next to the bed)
5. **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 eleven activities of Table 4, but they have different meanings and execution modality depending on the context of activity. These building blocks were 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 *self-care*, *mobility* and *social isolation*. It was clear that a choice had 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. From here the step to the initial scenario presented in D1.2 was made.

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

- *Initiating*: when the robot notices the user has not drunk enough, it reminds the user to have a drink.
- *Monitoring*: the robot monitors when the user eats and/or drinks something.
- *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 by Fraunhofer as unfeasible within the scope of the project. Adding such abilities of physical support and transport would be very desirable in the future as it would enhance the independence of elderly persons. But because it is technically not feasible, and would also provide additional complexities of human-robot safety, for now we will first focus on object-related tasks.

1.7 Initial system functionality

The above contains: personalisation/memory/planning (WP3), interface/empathic-expressive behaviour (WP2), activity recognition (WP4), re-ablement (leaving 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).

2 Focus groups II

The second round of focus group meetings were again held in the Netherlands, UK and France. During this second round the initial scenario, which was the result of D1.2, was presented to three separate target groups: 1) elderly, 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. The goal of these focus groups was to receive feedback on the initial scenario, which could be used to optimise the scenario and create phase one scenario. Participants who participated in the first round of focus groups were not excluded from the second round (on the contrary). Nevertheless the number of participants still needed to grow as the in the first round the target number of participants had not been met yet.

2.1 Method

2.1.1 Participants

Elderly persons and formal caregivers were contacted through care organizations or personal networks. Informal caregivers were contacted through personal networks and through care organizations. Participants from the first round of focus groups as well as new persons were contacted. The criteria for selection for all target groups were similar to those of the first session.

In total 97 persons participated in the study:

- Thirty-nine elderly persons (12 male, 27 female) with a mean age of 75.0 years old participated in focus group meetings in the Netherlands (13), UK (5) and France (21). All elderly persons were still living at home and receiving some form of care assistance (e.g. home care, Care TV, day care).
- Thirty-four professional caregivers (3 male, 31 female) participated in focus group meetings in the Netherlands (12), UK (3) and France (19). Caregivers' professions ranged from care workers, nurses and psychologists to managers. All professional caregivers worked closely with the elderly.
- Twenty-four informal caregivers (5 male and 19 female) participated in focus group meetings in the Netherlands (6), UK (4) and France (14). Informal caregivers took care of (one of) their parents, their spouse, neighbour, or their aunt. In one case 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 3-10 participants in a room with a round table formation. The session consisted of three parts:

1. Feedback on the results of the previous focus groups.
2. Explanation of scenario development and first comments.
3. Feedback on the graphical scenario.

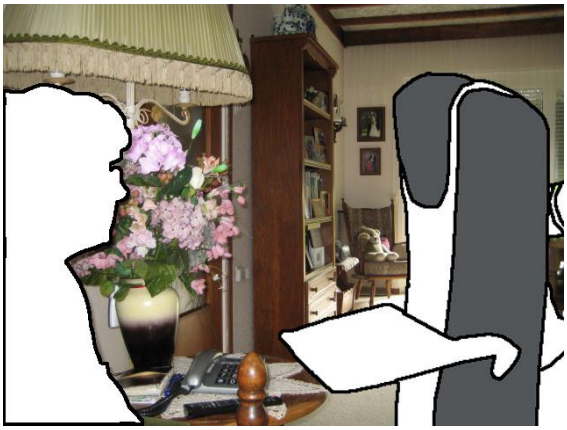
During the first part of the session the goal of the previous focus group sessions (an inventory of problem in daily life threatening independent living of elderly) was explained, followed by the result of the previous focus group sessions (i.e. the top 3 of most problematic activity domains). After this explanation participants were asked if they recognized their own opinion in these domains, if their problems fit these three main categories, if we understood their problems correctly and if they had any other comments.

During the second part of the focus group the steps taken between the three main problematic activities and the initial scenario were explained to the participants. Further, it was explained that this scenario was only a starting point and that we knew that this single activity does not make elderly capable of living independent for a longer period. Finally, a simplification of the initial scenario was verbally explained to the participants (i.e. “a machine notices if you haven’t had a drink in over an hour and can bring you a bottle of water”). Participants were asked to comment on this scenario using semi-structured questions (participants were asked, for example, to say if they saw this happening, how a machine could do such a task, what the machine should certainly not do, what kind of behaviour the machine needed to have and what kind of machine it should be).

Thirdly, each participant was given seven pictures (printed as one picture per A4 paper format) showing a graphic version of the scenario (see Pictures 1 – 7). While showing the picture to the participants the researcher gave a more detailed explanation of the action depicted. Participants were first asked to comment on the whole scenario and secondly give feedback per picture using semi-structured questions. These semi-structured questions covered topics concerning interaction, sensors/memory, recognition, and environment. Participants were also asked, for each picture, if they had any other comments. The duration of the focus groups varied between 1.5 and 2 hours.

Picture 1. User sits on the couch.

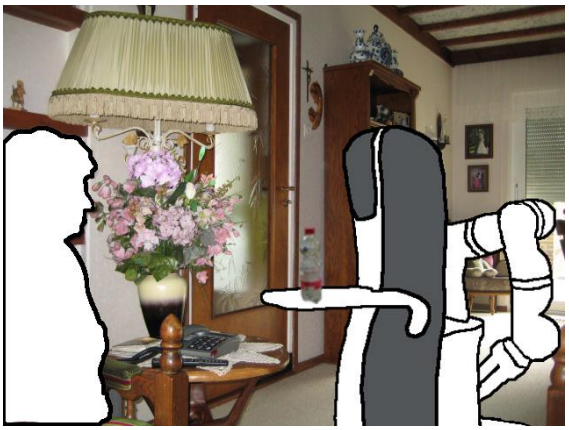
Picture 2. Robot approaches user.



Picture 3. Robot reminds user to drink and offers to fetch a drink from the kitchen.

Picture 4. Robot picks up bottle of water in the kitchen.

Picture 5. Robot enters living room.



Picture 6. Robot presents bottle to user and suggest to buy larger bottle next time.

Picture 7. Task is complete.

2.1.3 Data-analysis

A summary of the (qualitative) results of the focus groups were retrieved from the audio recordings. From these summaries a list was composed highlighting the feedback per country and target group.

2.2 Results

All three target groups in France, UK, and the Netherlands confirmed that the three problematic activity domains (i.e. self-care, mobility and social isolation) represented the problematic activities of elderly correctly. Elderly participants in the UK also stated that these three problematic activity domains were also in the right order. Participants in France, in addition, expressed their preference for entertainment functionalities (e.g. musical robot, gaming partner).

All feedback expressed by the participants during the third and final part of the focus group sessions could be grouped into eight different topics: 1) task execution, 2) visitors, 3) information, 4) behaviour of the robot, 5) camera usage, 6) robot appearance, 7) environment, and 8) additional robot functionalities (see Tables 5 – 12).

During the second part of the focus group participants expressed their preferences and expectation of how a smart machine should execute the task of bringing the user a bottle of water. Most participants thought that a machine that could bring the user a bottle of water (as a starting point) had potential. However, especially participants in the Netherlands preferred elderly to do tasks themselves as long as possible or work together with the robot while performing the task. Most participants expected (and preferred) they would be able to talk to

the robot and that the robot would be able to speak back. Participants of all three target groups were unable to agree within their group on how the machine should look. Overall three different opinions were expressed:

1. Several participants thought the machine should look friendly and should have human features (e.g. a face, eyes).
2. Some participants thought the machine should look like a machine because it will never be a human and therefore it should not look like one.
3. Other participants thought that the looks of the machine was not important. For this group it was only important if the machine would work properly and would help them.

Further, all participants agreed that the machine should not be insisting, too pushy or act too dominantly. Often mentioned during this second part of the focus group was that the machine should be programmed according to the users preferences and the behaviour should be tuned to each user.

Table 5. Feedback concerning the execution of the task *robot brings bottle of water to the user.*

No.	Execution task	Country – target group
1.	The robot should be programmable to match personal user preferences	All
2.	The users should fetch the drink themselves if they are still capable of doing it themselves	FR – elderly NL – professionals NL – elderly
3.	The robot and the user should perform tasks together when the user can only partly perform the task (e.g. user makes the coffee and the robot brings the coffee to the living room)	NL – professionals NL – elderly
4.	The robot should have a flexible day schedule which is adaptable (even during the day) to personal preferences	NL
5.	The robot should approach the user on “fixed” times (these fixed times are allowed be a bit irregular, otherwise too predictable)	NL – informal carers NL – elderly
6.	Both the user as the robot should be able to take initiative – flexible or adaptable to personal preferences (e.g. for some people just a reminder is enough)	UK – informal carers UK – elderly NL
7.	The robot should have its own place in the room (and should not follow the user everywhere in the house)	All
8.	The user should be able to name the robot and the robot should respond to its name calling	UK – professionals NL – informal carers NL – elderly
9.	The robot should announce its presence before approaching the user to avoid scaring or surprising them (beeping sound/blinking lights – adaptable to personal preferences)	All
10.	The robot should move slowly/gently (speed of the movements of the robot should also be adaptable to personal preferences)	UK – informal carers UK – elderly NL – informal carers NL – elderly
11.	The robot should call the user by their first name of family name – adaptable to personal preferences	UK – elderly NL – informal carers NL – elderly

12.	The robot should recognize objects and give options for these – only for things the user is not capable of doing himself/herself anymore + only relevant options + not too many	UK – informal carers UK – professionals NL
13.	The robot should ask open-ended questions (e.g. What would you like to drink?)	FR – elderly UK – professionals NL – informal carers
14.	The robot needs to be controllable by a user with impaired vision as well as a user with hearing problems – there should be more than one method of communication	UK – informal carers UK – professionals NL – informal carers NL – professionals
15.	The user should be able to control the robot with speech	UK – informal carers UK – professionals NL
16.	The user should be able to control the robot with a remote control/screen/keypad/head movement (2nd choice)	UK NL – informal carers NL – professionals
17.	The robot should not have buttons, operating buttons is difficult for older users	NL – informal carers NL – elderly
18.	The robot should be able to speak	All
19.	It should be possible to have a functional/practical conversation with the robot (task related)	UK – professionals NL – informal carers NL – elderly
20.	It should be possible to have a conversation with the robot (e.g. about the weather, activities performed or the users´ feelings)	NL – professionals NL – elderly
21.	The robot should (always) give feedback	UK – informal carers UK – professionals NL – elderly
22.	The robot should alarm carer if the user says “No” after so many reminders/if the user has not drunk for several hours	UK – informal carers UK – professionals
23.	The robot should have the ability to recognize favourite cup/cutlery	FR UK – informal carers UK – professionals NL – professionals NL – elderly
24.	The robot should have priority when moving around in the house, a person should get out of its way	UK – elderly UK – professionals
25.	When the robot sees a person (or pet) on its way the robot should freeze and wait until the person (or pet) passed by	NL – professionals NL – elderly
26.	The robot should monitor if the water is drunk, give reminder if the user has not drunk anything	NL – professionals NL – elderly
27.	The robot should clean up the glass/do the washing up	UK – informal carers UK – professionals NL – elderly

Table 6. Feedback concerning the situation when there is a visitor in the house.

No.	**Visitor**	**Country – target group**
28.	When there is a visitor the robot should go into “stand-by”, except when the user wishes for it to stay active	All
29.	When there is a visitor the robot should only perform priority 1 tasks (e.g. reminder for medication, toilet – adaptable to personal preferences)	NL – informal carers NL – elderly

30.	When there is a visitor in the house, the role of the robot switches to servant	NL – professionals NL – elderly
31.	The robot should recognize and remember visitors	NL – informal carers NL – elderly
32.	The robot should greet visitors	UK – informal carers NL – informal carers

Table 7. Feedback concerning entering information, information storage and the access to information on the robot.

No.	**Information**	**Country – target group**
33.	The robot should know all information about the user (medical record, family, friends, hobbies, day schedule)	UK – elderly UK – professionals NL – professionals NL – elderly
34.	The robot should learn the day schedule of the user, it should be "raised" by its owner	UK – professionals NL – elderly
35.	Only functional/remarkable information should be presented at the end of the day	UK – professionals NL – professionals NL – elderly
36.	Information (selective) should be stored	FR UK – informal carers UK – elderly NL – elderly
37.	The user should decide who can have access to the information stored	UK – informal carers NL
38.	The doctor should have access to the information stored	UK – elderly UK – professionals NL – elderly
39.	Personal information should be deleted as soon as the robot switches user	FR

Table 8. Feedback concerning the behaviour of the robot.

No.	**Robot behaviour**	**Country – target group**
40.	The robot should not act too forcing	UK NL – elderly
41.	The user should be in charge of the robot	NL – informal carers NL – elderly

Table 9. Feedback concerning the usage of a camera on the robot.

No.	**Camera usage**	**Country – target group**
42.	The robot should record video	UK – informal carers UK – professionals
43.	The robot should not have any cameras, that would be worrying (UK – elderly: monitoring with cameras is fine, but video should only be stored if something out of ordinary occurs)	FR – professionals UK – informal carers
44.	Other person should be able to drive robot through the house with the usage of a camera + joystick	UK – informal carers NL – professionals

Table 10. Feedback concerning the appearance of the robot.

No.	Robot appearance	Country – target group
45.	The robot should have human features (e.g. human posture, face)	FR UK – informal carers NL – professionals NL – elderly
46.	The robot should look like a machine	UK – informal carers UK – elderly NL – elderly
47.	The robot should look more friendly (luminous smile, warmer colours, more streamlined hand)	FR NL
48.	The robot should be smaller	UK – informal carers UK – professionals NL – professionals NL – elderly
49.	The robot should have 2 arms	UK – professionals NL – professionals NL – elderly
50.	The robot should have a screen	UK – informal carers UK – professionals

Table 11. Feedback concerning the environment (interior of the house).

No.	Environment	Country – target group
51.	The robot should be able to open doors within the house and drive over doorsteps, rugs, etc. (elderly themselves are willing to change their home interior for the robot)	All

Table 12. Feedback concerning additional robot functionalities.

No.	Additional robot functionalities	Country – target group
53.	The robot should have additional entertainment functionalities (music robot, gaming partner)	FR – informal carers NL – informal carers NL – professionals
54.	The robot should give reminders for medication (or appointment, going to the toilet)	All
55.	The robot should bring/hand over the medication	UK – informal carers NL – professionals NL – elderly
56.	The robot should recognize and respond to fall situation (alarm system)	FR – elderly FR – professionals UK – professionals NL – professionals NL – elderly
57.	The robot should be able of fetching and carrying objects	FR – carers UK – elderly NL – elderly

58.	The robot should be able to open bottles/cans	FR – elderly UK – elderly UK – professionals NL – informal carers NL – professionals
59.	The robot should be able to open the front door/windows	FR – professionals NL – elderly
60.	The robot should help the user to get up in the morning	UK NL – professionals NL – elderly
61.	The robot should help the user with support stockings	NL
62.	The robot should help the user to get up from a chair (offering its arm)	UK – elderly UK – professionals
63.	The robot should help the user with washing	UK NL – professionals NL – elderly
64.	The user should be able to make contact with friends/family through the robot for social talk	NL – informal carers NL – professionals
65.	The robot should suggest/challenge the user to exercise/exercise together with the user (e.g. for rehabilitation purposes)	NL – informal carers NL – professionals
66.	The robot should monitor	UK – informal carers NL – professionals NL – elderly
67.	The robot should be able to cut (e.g. vegetables)	NL – professionals NL - elderly
68.	The robot should be able to do household chores (e.g. change the bed sheets, dust)	UK – elderly NL – elderly
69.	The robot should be able to help with shopping	FR – elderly UK – elderly

2.3 Conclusion

From all feedback expressed during the focus group and listed in the Tables 5 – 12 it can be concluded that there are no major differences between the opinions of the three different target groups or between the three countries. Participants of all three target groups in France, UK, as well as in the Netherlands stated that it is most important that the robot should be personalised to match the personal user preferences. This personalisation of the robot concerns for example how the robot executes tasks, the user-robot interaction, what happens when there is a visitor in the house, which information will be stored, who should have access to the information stored, the usage of cameras, how the robot should look, and which additional functionalities the robot should have.

2.3.1 Execution task

Participants in France and the Netherlands stated that it is important that the user should perform tasks themselves as long as possible. Thus, elderly persons should fetch the drink themselves if they are still capable of doing this. When a user can only perform a task partly, the robot should only support that part of the task the user has problems with, for example: when the user is still capable of making coffee but unable to bring to coffee to the living

room, the robot should only assist the user in carrying the coffee. Further, most participants in the Netherlands and UK agreed that it should be possible that both the user as well as the robot should be able to take initiative; some elderly persons only need a reminder to get a drink, in those cases the robot should take the initiative, but others only need physical support. The latter group should be able to command the robot to get them a drink from the kitchen.

All focus group participants agreed that the robot should have its own place in the room where it should go to (and charge) when it is not needed. When needed the robot should announce its presence before and while approaching to user in order to avoid scaring or surprising the user. Depending on the user the robot should make a beeping sound or should have blinking lights. The movements the robot makes should be gentle and slow, but users should have the possibility to adjust the speed to their personal preferences.

Almost all participants in the Netherlands and UK found it useful if the robot could recognize objects and give relevant options for these (e.g. when a robot notices there is an empty cup on the table it should give the option for refilling the cup or the option to clean the cup to the user). However the robot should only give options for tasks the user cannot perform themselves and also not too many options. Further, the robot should also be able to detect specific objects according to most participants in France, UK, and the Netherlands (e.g. favourite cup of the user for drinking coffee).

All participants expected and wanted the robot to be able to speak. They also preferred if the robot could understand their verbal comments. However it was mentioned several times that the robot should be controllable by users with impaired vision as well as by users with hearing problems. Therefore participants thought that there should be more than one method of communication. As a second choice users in the Netherlands and UK thought a remote control, screen, keypad or head movements were good options to control the robot.

2.3.2 Visitor

All focus groups in the three countries agreed that when the user receives a visitor the robot should go into “stand-by”, except when the user wishes that the robot stays active. Some participants stated that the robot was still allowed to remind them to take medication and some saw no objection when the robot would remind them to go to the toilet. However, not all agreed on this point. Further, the robot should recognize, remember and greet visitors according to participants in the Netherlands and UK.

2.3.3 Information

The robot should store, or have access to a variety of information about the user (e.g. medical record, hobbies, family, friends, day schedule) according to elderly and professionals in the Netherlands and UK. The robot itself should not store all information input during the day, but only specific information should be stored (e.g. only information when something out of the ordinary occurs). The users should be able themselves to decide who can have

access to this information. Elderly in the Netherlands, as well as elderly and professionals in the UK, stated that the general practitioner (GP) of the user should have access to this information. Some elderly in the Netherlands stated they liked this idea because they did not always tell everything to their GP or they sometimes forget to tell things to their GP. These elderly also liked if someone else (e.g. their GP) can notice if something out of the ordinary occurs, because sometimes elderly people do not notice this themselves. The robot can provide additional medical information to their GP from which the user can benefit.

2.3.4 Robot behaviour

One comment that was stated in almost all focus groups was that the robot should not act too dominant. When a user indicates he/she does not want to have a drink, even when it had been several hours since the user had drunk, the robot should not force the user to drink water. The robot should stay friendly and the user should always stay in charge of the robot. Professional caregivers in the UK agreed that the robot should not act too forcing, however this group also liked idea of the robot bringing the user immediately a drink without asking or even after the user says no.

The robot could take different roles. When the user asks the robot to bring him/her a drink and the robot executes the whole task alone, its role is that of an assistive device or a butler. However, most participants agreed that the user should do things themselves as much as possible. So when the user wants the robot to perform a task the user is still capable of, the robot should autonomously decide to refuse this if this is in line with the re-ablement role or the aim of sustaining independence (“use it or lose it”). This should be done in an empathic manner as the robot should motivate the user to perform the tasks themselves. Some participants also preferred to execute tasks, which they are not capable of doing alone, together with the robot. In the example of the robot supporting the user with carrying the coffee to the living room (see 2.3.1), the robot functions as a co-learner as it learns from the user which part of the activity “getting coffee” the user cannot perform and supports only this part. The re-ablement role and the co-learner may overlap in their effective behaviour. The difference between the two lies in the aim of these roles in supporting independence. The re-ablement coach intends to improve the capabilities of the user so he/she can finally perform the tasks ideally alone again, while the co-learner role is more focussed on the robot adjusting to the personal (and changing) preferences of the user.

2.3.5 Camera usage

There was some contradiction concerning the use of cameras. During the focus group sessions no questions concerning the use of cameras were in first instance asked by the researcher, but during most focus groups this topic was brought up by the participants. Some of the participants wanted the robot to have a camera so it could record video when needed or requested by children of the user, for example. Another group expressed their worries about having a camera on the robot, because of privacy issues. Surprising was that elderly themselves showed less concerns about using cameras for monitoring purposes.

2.3.6 Robot appearance

After seeing the graphical scenario, most participants found the robot rather unappealing. Most participants would like the robot to be smaller and to look more friendly. In order for the robot to look more friendly, participants thought it should have for instance a smile, warmer colours or a more streamlined hand. Most participants also preferred the robot to have more human features (e.g. human posture, face). Also some participants would like the robot to have two arms, partly because it would look more human, but also because participants thought the robot would need two arms to be able to perform more difficult tasks in the future. Note, it has been documented in the Human-Robot Interaction literature that human-like appearance creates expectations of human-like intelligence and skills of the robot (Goetz et al, 2003). The appearance preferences as mentioned by the focus group members therefore need to be interpreted accordingly. In Accompany the appearance of the robot was given, and it was beyond the scope of the project to change the appearance.

2.3.7 Environment

There are some challenges for the robot concerning the interior of homes of elderly people. All participants indicated that most houses of elderly today still have rugs on the floor which can cause problems (e.g. the robot could accidently roll up the rug and cause a trip hazard). Also it was commonly feared that for most living rooms the robot would be simply too big. However elderly themselves are willing to change the interior when a robot would arrive, and some elderly already changed their home interior as they used a walker or wheelchair. Professional and informal caregivers also thought the houses of the elderly in the future would be more suitable for the robot as people will have a more modern interior. Further, participants expected the robot to have problems with doorsteps, opening doors and stairs.

2.3.8 Additional robot functionalities

Participants came up with lots of different additional functionalities for the robot. Most often mentioned functionalities (not in order of importance) concerned:

- Medication: Participants would like the robot to give the user a reminder when it is time for their medication. Also some participants would like the robot to bring the medication to the user. The robot does not necessarily have to check if medication has been taken as participants thought this would almost be impossible (if a user does not want to take their medication they will find a way to fool the robot). The robot should also give reminders for appointments (agenda function) for example, and when it is time to go to toilet (wanted by the Dutch elderly).
- Entertainment: Participants liked it if the robot would be able to function as a game partner or as a music robot. Further, participants also wished they could use the robot as a machine to contact family/friends (e.g. Skype) for social talk.

- Alarm system: Professionals in the Netherlands, UK and France as well as elderly in the Netherlands and France also liked the idea of a robot recognizing and responding in a fall situation.
- Opening bottles/cans: Almost all participants expressed the need for the robot to open the bottle before handing the bottle over to the user as this is often difficult for elderly people.
- Self care: Participants in the Netherlands and UK would like the robot to help users getting out of bed in the morning and support them in washing.
- Exercise: Participants in the Netherlands suggested that the robot could also exercise together with the user (e.g. for rehabilitation purposes). This could be done for instance through somebody on a screen demonstrating the exercise. The robot should further not only show the exercise but also challenge the user to participate.

3 Scenario

3.1 Introduction

To give guidance to the development of the Accompany robot throughout the project, a scenario will be adopted. To give direction to the distribution of the work three sub-scenarios will be formulated that will be materialised at prm 12, prm 24, and prm 36. These sub-scenarios are incremental and will in technical sense build up to the final prototype answering the overall scenario.

The first work package (WP1) in the Accompany project deals with the need of users and their preferences regarding the functionality of the robot. The scenarios to be developed will be in line with the results of the user consultations that have been organised in three countries (i.e. the Netherlands, France and UK) for this WP1.

Besides the preferences of the target population, the Accompany scenario also needs to be shaped by the feasibility of the technical development within the project, not every wish of the users can be built during this project. This requires a selection from the needs collected guided by the current ability of the Care-o-bot and the projected potential for advancement.

The user panels group results indicate during the first round of focus groups that the highest need for a robot is within three domains of human activity:

1. Self-care (feeding, grooming, washing, toileting, etc.)
2. Mobility (making transfers, mobility in and around the home, etc.)
3. Social participation (visiting others, communicating, receiving visitors, etc.)

As it is clear that the robot will only be able to perform a (very small) subset of the activities listed, the idea was to make a strategic choice out of this collection. The fetch and carry task of the Care-o-bot going to the kitchen and getting (the user to get) something to drink was selected as the (initial) scenario task.

Moreover, the robot is projected to perform as three types of supporting device. The robot should function as (see page 15):

a) Assistive device/butler role
b) Re-ablement coach
c) Co-learner

Some narrative scenarios examples per robot role are given below. Example a) corresponds to the a) robot function mentioned above. This is ditto for example b) and c):

a) Mrs A lives alone and can be considered a frail elderly. She uses the robot as a replacement of one visit of home care. The robot supports her in her daily routine.
   - *Example of getting something to drink.* Robot monitors dehydration and supports the user in offering and getting drinks from the kitchen.

b) Mr B just is recovering from a hip replacement surgery. Part of the after care of this intervention is that a robot is installed in the patients´ home for a period of three months and this robot monitors the rehabilitation process and actively intervenes with suggestions and reminders. The purpose of the robot is to act as re-ablement coach.
   - *Example of getting something to drink.* Robot monitors drinking behaviour and stimulates the user to get a drink from the kitchen, aiming at relearning his habits of taking good care of oneself, being active and self-dependent as much as possible.

c) Mrs C lives alone in her apartment and has increasing difficulty in successfully performing the routines of daily live. She is capable of doing many things herself but for a number of tasks she really needs some support. As this need for support occurs at different moments throughout the day she uses a robot to support her. She calls for its support when it is required and explains the robot what she wants and gives guidance to its functioning. The robot is sensitive for instructions and remembers the preferred type of support by Mrs C and can reproduce this.
   - *Example of getting something to drink:* Mrs C shows the robot what it is she needs as assistance and the robots shapes it activities to allow Mrs C to overcome her difficulties.

To shape these roles, various aspects of the robot need to be developed in addition to the current Care-o-bot functionality, namely:

- Empathic behaviour
- Intuitive interfacing
- Memory function
- Monitoring environment state and user actions

To explain the functioning of the robot within the drink fetch and carry task, this task is broken down into a number of steps, together building the scenario. These steps may differ depending on the role the robot is supposed to take. In the overview below this is indicated with a) the robot as an assistive device/butler role, b) the robot as a re-ablement coach, and c) the robot as co-learner.

1. Robot sits with user
2. Visitors come
3. Robot reminds user of need for drinking, empathically enriched
4. Need for drink
   a) Robot signals agreement for drink
   b) Robot discusses need for drink
   c) Robot is sensitive for user preferences in suggesting the user to drink something
5. Go to kitchen
   a) Robot goes to kitchen
   b) Robot and user go to kitchen

   c) Robot knows under which conditions joining the user in going to the kitchen is required
6. Get water
   a) Robot fetches water and prepares drink
   b) Robot supports user in getting drink
   c) User indicates how the robot is to support
7. Bring drink to sitting room
   a) Robot brings water on tray
   b) User brings water
   c) Robot helps user by carrying when needed
8. User drinks water
9. Robot engages user in entertainment

This somewhat small scenario may seem a minor addition to the care of elderly at home, but the fact that this has not been available before in an autonomous but socially acceptable and empathic robot functioning in a non-structured environment indicates there are major challenges to be taken (although internet clips communicate otherwise). This scenario has been communicated, evaluated and approved in the second user panel meetings. This was reported earlier in this deliverable. The participants have, faced with the possibility of such functioning of a robot, expressed many expectations regarding the way the role of the robot actually works in practice. These will be involved in the further detailing of the behaviour of the robot and development of its capabilities.

3.2 Sub-scenarios

The desired end-state scenario will be realised -in part- at the end of year 1 and again at the end of years 2 and 3. For those years sub-scenarios are formulated. The functionalities available through the sub-scenarios will build together the functionalities of the robot described in the end-state scenario which will be available in final form at prm 36. With the final robot prototype at prm 36, the required functionality should be available to make the end state scenario reality.

In demonstrating the partial functionality of the system in the first 2 prototypes, slightly adapted tasks may be required, being less complex but still meaningful (e.g. closing the fridge door on the basis of external sensor information rather than fetching a bottle on the basis of internal sensor information). This makes a more meaningful impression than a partial (non-functional) ability to fetch a bottle.

Scenario end of year 1

This scenario should be ready for first review. Prior to this activity, the user's daily schedule has been entered into the robot's memory (by researchers), including a 5pm medicine reminder. The numbers between the [ ] refer to the outcomes of the second focus group as stated in Table 5 – Table 12.

1. The user sits on the sofa and watches television, while the robot is located in its default location (charging) – [1, 7]
2. Shortly before 5 pm the robot leaves charging station and approaches the user[2] – [1, 5, 6, 9, 10, 51]
3. The robot stops at a socially appropriate distance/orientation from user – [40]
4. The robot greets the user by bowing – [1, 11, 40]
5. The robot reminds user to take medication at 5pm. The action possibility "Serve my medication" is displayed on the user's tablet with a big label (compared to other action possibilities shown, e.g. "send me back home") to highlight its relevance. If the user selects this action possibility then a new action possibility pops up on the GUI "accompany me to kitchen" (The robot can cope with different languages, depending on user preference) – [1, 6, 16, 40, 54, 65]
6. The user selects "accompany me to kitchen" (*re-ablement* or *co-learner variant*) and goes together with the robot to kitchen. On arrival, the user takes the medication and a bottle of water from the fridge and places both items on the robot's tray. The user and the robot both move back to the living room while the robot is carrying the water and medication (*re-ablement* or *co-learning variant*). In the living room the user takes his/her medicine – [1, 2, 3, 10, 16, 51, 57, 65]
7. The robot senses that fridge door is still open and communicates this to the user. The tablet of the robot shows a new action possibility "close fridge door together" – [1, 2, 3, 6, 16, 40, 65, 66]
8. The user selects "close fridge door together" (*re-ablement* or *co-learner variant*). If the user does not select it then the label becomes bigger, meaning it becomes more urgent for execution. If the user does not select to close the fridge door then the robot will remind the user again after 5 minutes via the label on the tablet and expressive behaviour to attract the user's attention – [1, 2, 3, 10, 16, 51, 57, 65]
9. After the user has selected "close fridge door together" the user and the robot go to kitchen together. The user closes fridge door and together they return to sofa – [1, 2, 3, 10, 51, 65]
10. When they have returned to the sofa the robot shows new action possibilities such as "watch TV" and "send me back home" – [1, 6, 16, 40, 53]
11. When the user selects "watch TV" the robot will adopt an empathic position/orientation next to the user and they both watch TV together. The robot uses comfortable distance/orientation towards user. When selected "send me back home", the robot will go back to default position [1, 7, 10, 16, 40, 51, 53]

[2] The robot approaches in a non-threatening manner using expressive behaviour, appropriate speed and proxemics preferences

Scenario end of year 2

This scenario will be shown at the second review. Before the end of year 2 the integrated functionalities will lead to a prototype. This prototype will used in the HZ, Madopa, and UH evaluation. Again the numbers between the [ ] refer to the outcomes of the second focus group stated in Table 5 – Table 12.

1. The user sits on the sofa, while the robot is located in its default location (charging) – [1, 7]. The user squeezes the table to attract the robot's attention.
2. The robot leaves charging station and approaches the user. Its movement is coupled to the way the table has been squeezed – [1, 6, 9, 10, 51]
3. The robot stops at a socially appropriate distance/orientation from user – [40]
4. Robot reminds the user that he/she has not had a drink for 3 hours. The tablet shows amongst others the following action possibilities: "accompany me to kitchen" and "send me back home". If the user selects the latter option, the robot will approach and/or remind the user again after 5 minutes. The robot can cope with different languages, depending on user preference – [1, 6, 16, 40, 54, 65]
5. The user selects "accompany me to kitchen" (*re-ablement* or *co-learner variant*) and goes together with the robot to kitchen – [1, 2, 3, 10, 16, 51, 65]
6. When arriving in the kitchen the user fetches a drink from the fridge and places it on robot – [1, 2, 3, 57]
7. Both robot and user move back to the sofa, while the robot is carrying the drink (*re-ablement* or *co-learning variant*). Robot places the object on sofa table (based on its memory of the user's preferred location to place objects in the living room) – [1, 2, 3, 10, 51, 57]
8. The robot observes the user to check if the user is drinking. If he/she does, the robot will go back to the default position. If the user is not drinking, the robot will wait and remind the user to drink within 10 minutes by displaying the related action possibility on the GUI and using expressive behaviour to attract the user's attention – [1, 6, 7, 10, 26, 40, 51]

Scenario end of year 3

This scenario will be ready for the third and final review and will represent the final outcome of the project in terms of advancing the development of autonomous, socially acceptable and empathic home companions for the elderly. Elements of it will be used, as ready, for the final evaluation at UH in project year 3.

1. The user sits on the sofa, while the robot is located in its default location (charging) – [1, 7]
2. The user wants to play a game and squeezes the tablet gently – [1, 6, 16, 53]
3. The robot leaves charging station and approaches the user – [1, 6, 9, 10, 51]
4. The robot stops at socially appropriate distance/orientation from user – [40]
5. The tablet contains pre-selected games based on the robot's knowledge on user preferences (*co-learner variant*) – [1, 16, 40, 53]
6. The user selects "play karaoke" , a game that involves (relatively) loud music – [1, 16, 53]

7. The door bell rings as there are two visitors at the door. The robot alerts the user and shows amongst others the action possibility “accompany me to the door” and “send me back home”– [1, 2, 6, 10, 16, 40, 51, 65, 66]
8. The user presses the label on the GUI hard to express urgency and to select action possibility “accompany me to the door”. Both go to the door, however the robot with faster speed than usual (*re-ablement* or *co-learner variant)* – [1, 2, 10, 16, 51]
9. When arriving at the door, the user greets the visitors. The visitors brought flowers and hands them over to the user. The robot also greets visitors by bowing and all go back to the living room – [1, 6, 10, 31, 32, 40, 51]
10. When arriving in the living room the user and both the visitors sit down at sofa table. The robot goes to default position – [10, 28, 51]
11. The user wants to put the flowers in a vase. However the vase is located on a high shelf and therefore difficult to reach for the user. The user activates the robot with urgency by squeezing the tablet and selects the action possibility “bring me the vase” that is shown on the tablet – [1, 3, 6, 16, 28, 57]
12. The robot grasps the vase and brings it to the user – [1, 3, 6, 9, 10, 12, 16, 40, 41, 44, 51, 57]
13. Robot goes fast to high shelf, fetches object and places it on tray. Then the robot returns to the sofa location (*assistive device variant*) – [3, 9, 10, 51, 57]
14. The user uses the tablet to select the action possibility “put vase on the table” and the robot places the vase on the sofa table – [1, 16, 41]
15. The robot suggests to the user to get the water from the kitchen together (*re-ablement* or *co-learner variant*). The user selects on the tablet the action possibility “fetch water together” and places the vase again on the tray of the robot (*re-ablement* or *co-learner variant*) and goes together with the robot to the kitchen – [1, 2, 3, 9, 10, 16, 40, 51, 57, 65]
16. In the kitchen, the user puts water into the vase and places the vase again on the tray of the robot. They both return to the sofa table while the robot is carrying the vase with water (*re-ablement* or *co-learner variant*). In the living room the user places the flowers in the vase – [1, 2, 3, 10, 51, 57, 65]
17. The user uses the tablet to signal to robot that it is no longer needed and the robot goes to default position – [6, 7, 10, 16, 28, 51]

3.3 Robot Functionalities (developed incrementally)

Year 1

- Navigation and localization
- Localization of user sitting on sofa, localization of user in room
- Memory – personal schedule for reminder function

- Tablet showing options and action possibilities[3]
- Expressive robot behaviour (lights, movement) and proxemics behaviour
- Detecting whether an object (any object) is located on tray or not
- Context awareness (sensor network)
- Empathic interaction via distance/orientation and tablet

Year 2, additional functionalities:

- Monitor drink intake user
- Memory from interaction history (preference to place objects in living room on sofa table)
- Recognition of drinking gesture

Year 3, additional functionalities:

- Multiple user tracking, identification of user among 2 people
- Personalization, memory
- Additional games
- Identify and recognize objects from high shelf (above eye level)
- Grasping one of several objects pointed presented to user as option
- Robot can place object on tray
- Robot can grasp object from tray and put it on the sofa table
- Memory of selected world knowledge (flowers in vase need water)
- Context awareness

[3] Note, the table that is based either on the robot's tray or can be placed elsewhere, will be used for three key purposes for WPs 2 and 3: Empathic human-robot interaction including perspective taking, tactile interface and visualisation of action possibilities (WP2), allowing the user to directly input data and user preferences (WP3), and to be in control of the robot if needed and select options for the robot's behaviour, e.g. during co-learning or when reacting to events (WP3).

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