DELIVERABLE 1.5

Final report on scenarios and system functionality of the ACCOMPANY system

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Short description

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 work conducted in WP1 focussed on detailing all aspects of the scenario in order for the development of the system to stay on target. Therefore, different user groups and experts were consulted. The user groups included elderly who are challenged in their independence and the care providers who are currently coping with these challenges and have expertise in solving the occurring problems on a day to day basis. This latter group comprised both formal and informal caregivers.

A functional scenario 1 and 2 were respectively demonstrated in by the end of year 1 and 2. By the end of year 3 a third scenario will be demonstrated. This deliverable is the final report on the scenarios and system functionality of the ACCOMPANY system and includes all three scenarios and the ongoing and formative development of these scenarios.

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1 Introduction

This document is the final deliverable of WP1 (see Figure 1). The previous four deliverables included the *Status of elderly care in Europe and the potential for service robotics* (D1.1), *Report on user and system requirements and first outline of system functionality* (D1.2), *Phase one scenarios and report on system functionality* (D1.3) and *Phase two scenarios* (D1.4). Phase three scenarios will be discussed in this deliverable.

In D1.1 the results of an inventory of problematic activities in independent living was reported from the literature and of current care provisions supporting independent living in four European countries (i.e. the Netherlands, Italy, UK and France). In D1.2 the needs, outlined by the literature and societal perspective on care provision reported in D1.1, were specified on the basis of user feedback (user group meetings).This led to an initial scenario for the ACCOMPANY robot development. D1.3 reported on the first outcome of the iterative detailing of the scenario which resulted in the phase 1 scenario. This was set in the perspective of three sub-scenarios leading to an end state scenario for the ACCOMPANY robot system supporting elderly by maintaining their independence in their home situation. D1.4 reported on the lessons learned from the scenario development. These include both those that led to adjustment of the details of the scenario in this phase and those that may lead to further adjustment in the remainder of the project.

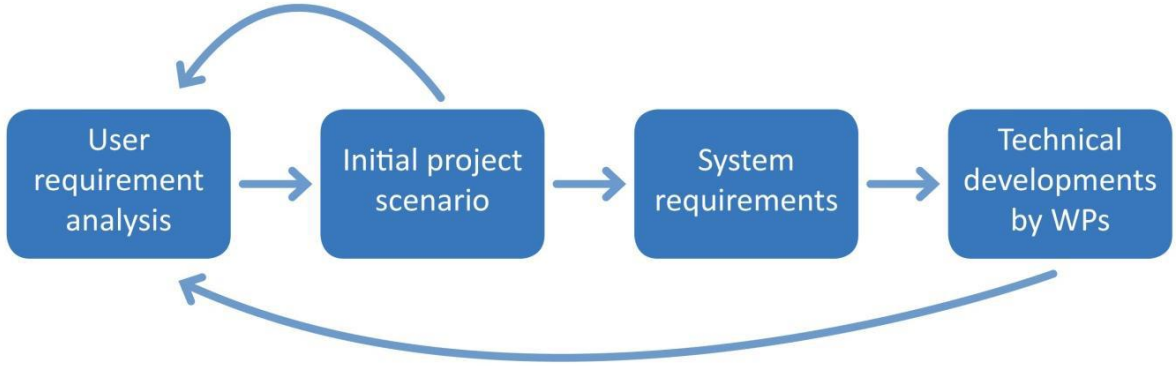

Figure 1. Progress in WP1 from user requirement elicitation to scenario definition and formulation of system requirements.

This deliverable is the final report on the scenarios and system functionality of the ACCOMAPNY system. Section 2 of this deliverable will describe the scenario as described in the DOW. Section 3 will describe the scenarios as realised per project year, including an explanation of the project results that influenced the scenario of each year. Finally the influences of the ACCOMPANY system will be described (section 4) and discussed (section 5).

2 Scenario as described in DOW

For this project we wanted to create a robot that is capable of supporting elderly in their daily life. This is a rather broad standpoint. Globally this means the key performance indicators at the start of the project were:

- To develop a service robot that can deliver a functional contribution to independently living elderly people;
- To develop a robot with acceptable social behaviour.

In the DOW also a persona (i.e. a model of a user that focusses on the user's goals) and illustrative scenario was described around Mary. This persona and illustrative scenario was rather broad as it includes many tasks and includes both key performance indicators.

Mary (78) lives alone and is visited by a caregiver every Tuesday, a cleaner every Wednesday and her only son visits every Saturday. On Monday the shopping arrives through the internet grocery service arranged by her son. Mary suffers from a heart condition and has rheumatism in her fingers and back. Upon returning home following a heart operation Mary has increasing problems with basic activities required for her independent living. Besides the fact that some physical tasks have become very tiring and some impossible for her, her forgetfulness is becoming more and more a problem – e.g. this year she almost forgot her son's birthday and missed attending her neighbour's 50 wedding anniversary celebration. She has had a number of visits from a re-ablement consultant who has taught her new ways to carry out household chores. This is necessary to make sure she only carries out low-impact household chores and refrains from high-risk activities such as standing on a chair to retrieve items from the top shelf. Chores that are high-impact were reviewed and reconsidered and some assistive technology was acquired, mainly for the bathroom. But also, Mary does not cook with heavy pots and pans anymore. She has special light-weight small pots, has learned to steam vegetables in a special steamer and she gets hot tea water and coffee from a dedicated machine attached to the wall.

Since her son was increasingly worried by the forgetfulness of his mother he tried to arrange additional home care for her on a daily basis. Instead the care organisation offered a robot as part of a smart home provision able to support Mary in a number of critical basic activities of daily life. As Mary disliked the idea of strangers entering her home and assisting her with private and other activities, she cautiously embraced the idea of having a supporting smart machine at her disposal continuously. The system was installed in her home in combination with a set of sensors that monitored the critical parameters in her home and was operational in two weeks. The system can perform a number of tasks on demand. Picking up items from the floor or getting something from the top shelf are now tasks that can be performed by the robot on her instructions. Another very helpful function is the indoor transportation of heavy groceries. After the delivery of the groceries the robot helps her to store the groceries in her preferred locations.

Besides the help the system provides on demand it also executes monitoring functions based on its sensors and the sensory system implemented in Mary's home. With help from her son, Mary designed a basic weekly schedule of her activities and the robots follows this schedule. It offers physical support but also reminds her of actions she is expected to take. It monitors whether incoming phone calls are answered and seeks Mary when she does not respond to the doorbell or phone calls. In general the system responds to Mary calling it, by seeking her and offering its communication functionality. When the robots detects unexpected inactivity from Mary, exceeding the set safety level, or finds Mary lying inactive on the floor, it gives an automated alarm to the agreed contact person. This turns out to be a powerful social alarm system, reassuring both for Mary and her son. She now sleeps well, reassured by the knowledge that if her heart failed again, the robot would detect this immediately from its sensor

readings and would raise the alarm. It had scared her very much the last time her heart failed as she laid on the floor and couldn't reach the phone. Luckily the neighbour had seen her from the window at that occasion.

Mary had initially been a bit apprehensive when her caregiver explained to her the many things the robot could do and remind her to do. Mary was afraid to have a system in the house that would dominate her and tell her continuously what to do and not to do. Mary was therefore pleasantly surprised that the robot had a range of communication and interaction skills – not exactly human-like, but very "natural" and pleasant in terms of how the robot moved and approached her, sought her attention, and how it presented information to her etc. Moreover, the robot behaved in a way that reassured her that: she was in control of what was happening in her own home; they could carry out tasks together; and together learn how to do things for the first time. Throughout the day the robot reminds Mary of essential elements such as her daily food intake, it keeps track of the cleaning activities which are not taken care of by the professional help and monitors her nutrition intake. Mary tends to drink too little because she simply forgets to drink. When this happens, the robot offers her one of the water bottles she keeps in the refrigerator. A feature Mary really enjoys is the endless recipe advise the robot can give her to choose from. The robot can order the required groceries and knows what is still available in her refrigerator.

At first, Mary thought the robot was an odd thing to have in her home. The re-ablement consultant had talked about the robot and what it could to for her, and she had seen pictures and a video of it. However, when the robot was installed in her home she had been pleasantly surprised. Its lean shape and diminutive size meant it could fit anywhere in her apartment. Furthermore, its friendly appearance, soft sounds and smooth movements were fun to watch and she quickly came to regard it as some sort of house animal with its own quirks and preferences. She felt comfortable around it immediately and her grandchildren came to see it the same day. She felt the robot had behaved well by keeping a respectable distance from the children but responding to them when they were pointing at it, asking questions or touching it. The way the robot moved showed her it meant no harm and merely wanted to help. She had been impressed when the robot made it clear to her that she had forgotten to take a drink for a while. When she took the offered water bottle it was pleasantly cool and the robot had made a very happy sound. She had laughed out loud, seeing how the robot was pleased that she had drunk the water. When Mary was still, so was the robot. But it was also always alert to the need to help her as soon as she started to move, for example picking up things she dropped or helping her into her coat when she wanted to go out. When the shopping arrived, the delivery man brought the crates to her kitchen and the robot lifted the heavier items onto the kitchen counter so she could put them away safely or open the packs to take out the smaller items inside. When there was nothing for it to do, the robot seemed to sleep or rest at the charging station. It felt she had a new housemate accompanying her in her daily life, which was there for her.

3 Scenarios as realised

The complexity of the scenario made it necessary to realise the scenario step by step. The intended functionality was realised incrementally in three consecutive sub-scenarios. The three sub-scenarios were formulated and materialised at prm 12, prm 24, and prm 36. The desired end-state scenario was

realised -in part- at the end of year 1 and again at the end of years 2 and 3. The functionalities available through the sub-scenarios together build the functionalities of the robot described in the end-state scenario which was available in final form at prm 36. These three scenarios developed are in line with the results of the user consultations that have been organised in three countries (i.e. the Netherlands, France and UK) for WP1. Also the different roles of the robot will be discussed in these scenarios.

3.1 Project results influencing scenario 1

To give guidance to the development of the Accompany robot throughout the project elderly people, informal caregivers and care professionals were consulted throughout the project. Besides the preferences of the target population, the Accompany scenarios were also shaped by the feasibility of the technical development within the project; not every wish of the users could be built during this project. This required a selection from the needs collected guided by the current ability of the Care-o-bot and the projected potential for advancement.

The first round of user panels group results indicated that the highest need for a robot is within three domains of human activity (see Deliverable 1.2 & Deliverable 1.3):

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 was 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 Deliverable 1.3, 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
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 scenario has been communicated, evaluated and approved in a second user panel meetings (see Deliverable 1.3). The goal of these meetings was to receive feedback on the initial scenario, which could be used to optimise the scenario and create phase one scenario. 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 Appendix 1, Table 1 – Table 8).

3.1.1 Scenario year 1

Below the functional scenario 1, which was demonstrated by the end of year 1, is described. In this scenario the robot seeks the user when the doorbell rings and monitors the user whether he/she has been drinking. The numbers between the [ ] refer to the outcomes of the second focus group (see Appendix 1, Table 1 – Table 8).

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 – [1, 5, 6, 9, 10, 51]
3. The robot stops at a socially appropriate distance/orientation from user – [1, 9, 10, 40, 51]
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]

3.2 Project results influencing scenario 2

After the functional scenario 1 was demonstrated by the end of year 1, the project development continued by realising scenario 2. In the second scenario the "getting a drink from the kitchen" task features besides and additional "getting a parcel by mail" activity. Initial this new scenario was as followed (the numbers between the [ ] refer to the outcomes of the second focus group (see Appendix 1, Table 1 – Table 8)):

1. The user sits on the sofa, while the robot is located in its default location (charging). The doorbell rings – [1, 7]
2. The user selects the action possibility "go to the door" on the tablet – [1, 3, 6, 16, 40]
3. The robot leaves charging station and moves to the door – [1, 7, 10, 51, 59]
4. At the door the parcel is placed on the robot's tray – [57]
5. The user selects the action possibility "bring me the parcel" on the tablet – [1, 6, 16, 40]
6. The robot moves towards the user and stops at a socially appropriate distance/orientation from the user – [1, 9, 10, 40, 51]
7. The user takes the parcel from the robot and the robot goes back to its default location – [1, 7, 10, 51]
8. The user has not drunk in 3 hours and the robot notice this – [1, 66]
9. The robot leaves charging station and approaches the user – [1, 6, 7, 9, 10, 40, 51]
10. The robot stops at a socially appropriate distance/orientation from user – [1, 40]
11. The robot reminds the user that he/she has not had a drink for 3 hours. The tablet shows the following action possibility "accompany me to kitchen". The robot can cope with different languages, depending on user preference – [1, 2, 3, 6, 16, 54, 65]
12. 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]
13. When arriving in the kitchen the user fetches a drink from the fridge and places it on robot's tray – [1, 2, 3, 57]
14. 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 drink 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]
15. 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]

During the technical realisation of this scenario the technical elements developed in the technical workpackages were integrated. The robot, the arm, the user localisation and identification, the user interface (tablet) were all integrated within the action sequence described in the scenario. When materialising the robot system functioning, evaluation sessions were conducted in order to contribute to a realistic and functioning scenario. Two experts were invited for two separate sessions. These sessions were based on a Heuristic evaluation (see Deliverable 1.4). After both sessions item lists were created together with the experts. Additionally a log book with observations on system functioning was created throughout the user evaluation sessions with elderly users at Zuyd. This logbook is different from the evaluations performed in WP6 as it concerned only system functioning not usage with end users. From these observations a third item list could be created. Deliverable 1.4 reports on the improvement of the quality of the materialised scenario as assessed by usability experts. This deliverable does not report on the effects of the scenario as assessed by users. This was reported separately under WP6.

Part of these lessons have led to changes in the details of the scenario, but have not changed the scenario itself. Overall it can be said that one of the main changes concern the interaction between user and the robot. More physical feedback to the user was necessary to make the user understand the intentions of the robot (e.g. the bowing of the robot after delivering the parcel or turning its torso when placing the drink on the table). These changes were made based on the interaction between human and robot, and not influenced by the roles of the robot.

3.2.1 Scenario year 2 – part 1

With all the changes implemented the year 2 scenario was as followed (the numbers between the [ ] refer to the outcomes of the second focus group (see Appendix 1, Table 1 – Table 8):

1. The user sits on the sofa, while the robot is located in its default location (charging). The robot mask on the tablet is “neutral” and the lights of the robot are blue. The doorbell really rings – [1, 7]
2. The lights of the robot turns yellow and the robot turns towards the door and the robot mask turns “excited”. The moment the robot sees the door the action possibilities “go to the door” pops up on the robot view on the tablet – [1, 3, 6, 16, 40]
3. The user selects the action possibility “go to the door” on the tablet – [1, 3, 6, 16, 40]
4. The robot moves to the door. Once at the door the tray moves up – [1, 10, 51, 57, 59]
5. The parcel is placed on the robot’s ray – [57]
6. The robot masks turns “happy” and the action possibility “bring me the parcel” appears on the tablet – [1, 3, 6, 16, 40, 57]
7. The user selects the action possibility “bring me the parcel” on the tablet – [1, 6, 16, 40]
8. The robot moves towards the user and stops at a socially appropriate distance/orientation from the user. The lights of the robot turn blue – [1, 9, 10, 40, 51]
9. The user takes the parcel from the robot. The robot nods towards the user and then moves its tray down. The lights turn yellow and the robot goes back to its default location – [1, 7, 10, 51]

10. The user has not drunk in 3 hours and the robot notice this – [1, 66]
11. The robot lights turn yellow and the robot leaves charging station and approaches the table. The robot bows a little to look at the table. The robot masks turns "sad" and the action possibilities "go to the kitchen for a drink" and "remind me later" appear on the robot view of the tablet – [1, 2, 3, 6, 7, 9, 10, 16, 40, 51, 54, 65]
12. The user selects "go to the kitchen for a drink", the robot mask turns "neutral" and the user and the robot go to the kitchen together – [1, 2, 3, 10, 16, 51, 65]
13. When arriving in the kitchen the robot moves its tray up and the user fetches a drink from the fridge and places it on robot's tray – [1, 2, 3, 57]
14. Both robot and user move back to the sofa, while the robot is carrying the drink – [1, 2, 3, 10, 51, 57]
15. The user is seated and the robot stops next to the table and turns it torso towards the user. After this the robot places the drink on sofa table – [1, 2, 3, 10, 51, 57]
16. The robot moves back to the default position and the lights turn blue – [1, 7, 10, 51]
17. If the user did not have a drink after a certain period the robot lights turn yellow and the robot moves back to the table and bows a bit to see the table. The mask on the tablet turns sad and the action possibility "you should really drink something" appears on the robot view on the tablet – [1, 6, 7, 10, 26, 40, 51]
18. The user takes a sip and the action possibility disappears and the mask on the tablet turns "happy". The robot moves back to its default position and the lights turn blue again – [1, 7, 10, 26, 40, 51]

3.2.2 Scenario year 2 – part 2

A second round of user tests and evaluations took place in at MADoPA in France. The points of improvements of scenario 2 – part 1 were not implemented in scenario 2 – part 2 used in France. A similar scenario was tested here, with the exception of the additional *Squeeze Me* function (developed in WP2) which was implemented. This changed the scenario slightly. Firstly, it was possible for participant to squeeze the tablet during step 7, so the robot would bring the parcel faster. Secondly, the participants could squeeze the tablet during step 14, so the robot would move faster towards the participant.

3.3 Project results influencing scenario 3

After the functional scenario 2 was demonstrated by the end of year 2, the project development continued by realising scenario 3. In this scenario the squeeze me feature, "playing game" activity, visitors and "fetch vase" activity were added to the scenario.

3.3.1 Scenario year 3

The numbers between the [ ] refer to the outcomes of the second focus group (see Appendix 1, Table 1 – Table 8).

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 slowly. The movement of the robot is coupled to intensity of the squeezing – [1, 6, 9, 10, 51]
4. The robot stops at socially appropriate distance/orientation from user – [1, 9, 10, 40, 51]
5. The tablet contains the action possibility "bring me the game device". The icon displaying this AP is bigger than the other because the robot was taught that the user prefers playing games in the afternoon (co-learner variant). The user presses this AP button and the robot raises its tray presenting its built-in tablet pc which contains pre-selected games based on the robot's knowledge on user preferences (co-learner variant) – [1, 6, 16, 40, 50, 53]
6. The user selects "play karaoke", a game that involves (relatively) loud music – [1, 6, 16, 40, 50, 53]
7. The doorbell rings as there are two visitors at the door. The robot stops the Karaoke game, alerts the user and shows amongst others the action possibility "accompany me to the door". This is the biggest AP displayed on the tablet GUI – [1, 3, 6, 16, 40, 65]
8. The user presses the action possibility "accompany me to the door". Both go to the door together (re-ablement or co-learner variant). The robot adjusts its speed according to the user's walking speed (perceptual crossing) – [1, 3, 6, 10, 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 people go back to the living room. The robot recognizes that the user received flowers, and will add a new action possibility ("bring me a vase") to the tablet. The new AP "bring me a vase" appears with the highest likelihood – [1, 3, 6, 10, 12, 16, 32, 40, 51]
10. When arriving in the living room the user and both the visitors sit down at sofa table. The robot recognizes that the visitors and user are seated. The robot goes to default position – [1, 7, 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 selects the action possibility "bring me the vase" that is shown on the tablet. This AP is bigger than the others – [1, 3, 6, 16]
12. The robot grasps the vase from the high shelf, places it on the tray, and brings it to the user – [1, 3, 10, 12, 16, 40, 51, 57]
13. The tablet displays the action possibility "put vase on the table", but the robot also suggests to get some water from the kitchen together (re-ablement or co-learner variant). The user selects on the tablet the action possibility "fetch water together" and goes together with the robot to the kitchen. The robot adjusts its speed according to the user's speed (perceptual crossing). – [1, 3, 6, 10, 16, 40, 51, 57, 65]
14. In the kitchen, the user puts water into the vase that is positioned 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) – [1, 3, 6, 10, 40, 51, 57]
15. The tablet pc displays the action possibility "put vase on the table" but the user just takes it from the tray. The robot senses that the tray is empty and lowers the tray. The user places the flowers in the vase – [1, 3, 6, 16, 40, 57]
16. The user uses the tablet to signal to robot that it is no longer needed and the robot goes to default position – [1, 6, 7, 10, 16, 28, 51]

4 Projected impact of Accompany system

This project provided insight on the desired functionalities of a robot that enhances independent living of elderly people at home. When looking at the scenario described in the DOW (see chapter 2) we can see that there is a discrepancy between these desired functionalities and the actual functionalities this robot can offer. The Accompany system could have an enormous impact, however the robot must be capable of performing more tasks as it currently capable of. At the start of the project it was said that the robot should be able to deliver a functional contribution to independently living elderly people. Focus group results indicated that, in order to deliver a functional contribution, the robot should support activities within the activity domains mobility, self-care, and social participation. When looking at the tasks the robot is actual capable of doing, we see it can offer support with drinking (self-care) and fetch & carry (mobility). 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 indicated that there were major challenges to be taken (although internet clips communicate otherwise).

Further, this study provided also insight on the desired social interaction and its complexity. Many social capabilities have already been implemented in the system (WP2), for example:

- A context-dependent GUI that is grounded on the interplay between robot, person and environment;
- The expressive mask that allows to take the robot's perspective which enables empathic exchanges;
- Perceptual crossing;
- The Squeeze Me which is about expressivity in communication.

And although we accomplished a lot in this project, there is still long road ahead of us before a robot will be capable to function optimally, on a social as well as on a functional level, in the home of a user. Nevertheless it is important to state that participants were open to the idea of a robot supporting independent living of elderly people at home. However, such a robot must be intelligent in order to respond to the habits and wishes of the user and to collaborate in an acceptable manner with the user. The user also found the different roles of the robot acceptable. Different capacities of the robot could be linked to the different roles: a robot coach was allowed to be more strict and critical than a butler robot, taken in mind that the robot is capable of making this distinction.

5 Discussion

The idea of Accompany was to further develop the functionalities of the existing Care-O-bot robot in order to make it meaningful and suitable for delivering (care) support for elderly people in their home. Because an existing robot was used, users were capable to estimate and discuss the added value of such a robot and the problems paired to such a robot.

The results showed that the robot functionality is limited and more functionalities are required in order for the robot to be an added value in the home situation. For example: it should be able to support

more self-care tasks and mobility tasks that emerged from the first focus group sessions with elderly, informal carers and professional caregivers. And although many aspects are accomplished within this project, the robot still has a long road ahead until it can actual support elderly people in a meaningful way. Furthermore, the results highlighted another dimension, namely: the importance of the social skills of robots. In many projects the functional performance of robots is the main target, but by testing the robot in practice it was shown that a robot, besides the functional skills, should also have social skills in order to collaborate in an acceptable manner with elderly people and to provide meaningful support. Social skills are important in order to motivate people, to guide them in making daily choices and to convince people not to choose the most appealing and easy option. A robot should be capable to have the role of coach, which is very different than have the role of a butler. In this project progression was made with the realization of this, but in this workpackage the progression is mainly made in discovering the needs of the users within these different roles.

Appendix 1

Table 1. 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 2. 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 3. 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 4. 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 5. 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 6. 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 7. 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 8. 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