Grant Agreement number: 288899

Project acronym: Robot-Era

Project title: Implementation and integration of advanced Robotic systems and intelligent Environments in real scenarios for ageing population

Funding scheme: Large-scale integrating project (IP)

Call identifier: FP7-ICT-2011.7

Challenge: 5 – ICT for Health, Ageing Well, Inclusion and Governance

Objective: ICT-2011.5.4 ICT for Ageing and Wellbeing

Project website address: www.robot-era.eu

D2.2
First report on the structures of Robot-Era services

Due date of deliverable: 30/04/2012
Actual submission date: 14/05/2012

Start date of project: 01/01/2012 Duration: 48 months

Organisation name of lead contractor for this deliverable: YOUSE GmbH
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Version: 3.1

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Service)	
RE	Restricted to a group specified by the consortium (including the Commission Service)	
CO	Confidential, only for members of the consortium (including the Commission Service)	

Document History

Version	Date	Author	Summary of Main Changes
1.0	23-02-2012	Filippo Cavallo (SSSA)	First version of the template for Robot-Era Deliverables
1.1	03-04-2012	Sebastian Glende (YOUSE)	First ideas / draft to the partners for comments
1.2	13-04-2012	Sebastian Glende, Susann Klemcke (YOUSE)	Input from User Workshops Berlin
1.3	19-04-2012	Sebastian Glende (YOUSE)	Second draft to partners for input and comments
1.4	20-04-2012	Michela Aquilano (SSSA)	Feedback
1.5	21-04-2012	Fiorella Marcellini (INRCA)	Feedback
2.0	25-04-2012	Sebastian Glende (YOUSE)	Third draft to partners for input and comments
2.1	27-04-2012	Fiorella Marcellini (INRCA)	Feedback
2.2	30-04-2012	Michela Aquilano (SSSA)	Revision of the Coordinator
3.0	**14-05-2012**	**Sebastian Glende (YOUSE)**	**Final submitted version**
3.1	26-11-2012	Filippo Cavallo (SSSA)	Project Manager minor revisions

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Executive summary

The main aim of the document is to provide a first structure of services and functions that should be realised within the Robot-Era project.
The Deliverable 2.2 is the first outcome of the work done in task 2.3 "Robotic service optimization and design", which runs from month 3 until month 36 of the Robot-Era project.
In this task - starting from information collected in T2.1 - the Robot-Era services are designed and refined in order to have a structure which satisfies requirements defined by elderly people and other main target groups and potential customers. The results are fundamental for guiding the design of Robot-Era platforms and the definition of the scenarios for later experiments and tests.
Since the structure of services depends both on user needs and technical possibilities within the Robot-Era consortium, all Robot-Era members discussed the services' frame based on current Task 2.3 work and find a common agreement about services to be realized, refined and excluded.
The Deliverable D2.2 reports a wide range of service ideas, refined within workshops with user groups in Germany and Italy, and draws then a rough picture of services to be realized in the project.

1 Introduction and aims of the deliverable

WP2 aims to provide guidelines for designing, developing and validating the Robot-Era systems and services in order to support elderly people in coping with daily activities and to match users needs and expectations.
As a first step, the needs of elderly users have been analyzed within Task 2.1 (see deliverable 2.1 [1]), based on studies that have already been conducted in this field and on focus groups carried out with 49 elderly persons in order to preliminary evaluate if services and scenarios listed in Robot-Era proposal reflect elderly necessities and their view about useful services.
In a second step, the Task 2.3 conceived at a first glance the intended structure of services that the Robot-Era robotic systems could provide. This work took into account the requirements of potential users (described in detail in D2.1) and technical possibilities within the Robot-Era consortium. The most important guideline is to develop a robotic service system that could go beyond the level of research prototype and could be really marketable.

The results are fundamental for guiding the design of Robot-Era platforms and the definition of the scenarios for later experiments and tests. Since the structure of services depends both on user needs and technical possibilities within the Robot-Era consortium, all Robot-Era members discussed the preliminary services' frame and found a common agreement on what to realize, what to refine and what to exclude.

For the preparation of D2.2, the service ideas collected in D2.1 were discussed on the base of a secondary literature as well as knowledge from other projects regarding robotics. This information was then refined within workshops with user groups in Germany and Italy and with Robot-Era consortium to draw finally a rough picture of services to be realized in the Robot-Era project.

2 User requirements and considered functionalities

D2.1 describes in detail what functions and services are wished by elderly users and takes into account research from other precedent projects such as Pearl (by the University of Pittsburgh and Carnegie Mellon University, USA), Caro-o-bot II (by Fraunhofer Institute for Manufacturing Engineering and Automation, Stuttgart, Germany), RI-MAN (by Riken's Bio-Mimetic Control Research Center) and MOVAID (MObility and actiVity AssIstance System for the Disabled).
Starting from that wide range of potentially feasible functions for Robot-Era, a set of functions and services to be realized were chosen.
Following this process starts by discussing our target user groups. Afterwards, the most important functionalities are described again shortly to built a basis for the selection and compilation to a first service structure.

2.1 Target user groups

Before starting the selection a definition of target users is crucial to have a common understanding of the people we are developing for.

Robot-Era focuses on: 1) elderly end users to support them living independently, and 2) caregivers to improve the efficiency of care. The Robot-Era proposal defines the target users as follows:

The Robot-Era project would focus its actions on a specific target of elderly people:

- *male and female over 65 years old;*
- *with moderate health problems and motor and cognitive deficits;*
- *living alone or with their relatives but without a devoted caregiver.*

This choice is mostly motivated by the interest in investigating the interaction between technology and older people and its integration in the daily living of the end users, in order to support and not substitute the relationship between elderly and their family/caregivers. Older people have to be able to communicate his/her use-preferences and opinions on the Robot-Era services, actively participating in the technical development and design of the technologies.

But it is important to keep in mind the significant differences between different user groups older than 65 years:

- younger seniors (between 65 and 75 years old) focus on support of active living,
- older seniors (older than 75 years) focus on physical and mental support.

Even though the focus is mainly on elderly users at home, recent researches in comparable projects show, that it will be difficult to sell complex robots to domestic users given the expected price range of the final product – at least as long as prices have not fallen due to mass production.

Some projects such as „Pflege 2020" in Germany [2] and the FAZIT project [3] conclude that the future of care robots is rated rather pessimistically, due to assumed reservations of care patients and inclined issues of data privacy. This refers mostly to the primary care tasks which nowadays include a very close contact between caregivers and residents or patients.

But field trials by the Fraunhofer IPA and Bosch [4] showed a good acceptance of being served by robots. This applies particularly for secondary care tasks, such as logistics, information or accompany.

Therefore, public and private service organizations, e.g. insurances, domiciliary services, care facilities and municipalities should be considered as adequate buyers as well, since their services can benefit from robotics much more than single person household because:

- they can reach more users allowing much better utilization of resources
- they can save lots of to worker time cost by using robotics
- they are financially stronger then single users.

For these reasons Robot-Era services are conceived and structured for involving not only elderly people, together with their families and private caregivers, but also service organizations and their socio-medical workers that daily assist elderly to maintain them in their domestic context.

2.2 Potential functions and services from other research

To define robotic services for elderly, as a first step it was necessary to identify a wide spectrum of possible functions and of general attitudes regarding robots. Results of this are described in D2.1 [1] and a basis for D2.2, focusing on a first selection and structure of functions / services, that should be delivered by the Robot-Era-Robots.

D2.1 shows how manifold requirements are. On the one hand, they derive from various contexts such as organisational design, architectural design, software engineering, town planning, ergonomics, innovation management, marketing and more.
On the other, a large number of factors influence likes and dislikes of potential users - e.g.:

- the knowledge about new technologies
- the use of new technologies
- awareness

- concerns about legal, ethical, and privacy issues
- cost of devices
- resistance to "high tech devices" due to ergonomics
- concerns about fitting the technology into the environment
- concerns about stigmatisation
- difficulties in changing routines
- cultural backgrounds and so on.

The next chapters give a overview of the already identified task domains and general requirements.

2.2.1 Task domains

The identified task domains and use scenarios can be separated into indoor and outdoor scenarios. D2.1 already condensed the big number of possible functions to a reduced set of potentially interesting scenarios.

Table 1 shows a summary of results shown in D2.1 and describes these scenarios more detailed. The functions considered less important are written in grey letters.

2.2.2 General requirements

Besides the functional requirements there are more needs and wishes to consider in the design of Robot-Era platforms:

- Light, slender, not humanoid appearance
- Keeping in the background when not needed
- Promoting social interaction
- Robust and reliable function
- Adapting to user needs and decreasing health status over time
- Integrating into existing structure
- Guaranteeing privacy
- Guaranteeing controllability by user
- Flexibility: the platform should be adapted to the changing needs of the older population; high level of customization of the platform
- Opportunity of having fun with the robots (reading a book, playing games or giving up-to-date information at local level)
- Ease of use

Table 1 Summary of approved services shown in D2.1

FUNCTION	CONTEXT	MAIN ELDERLY OPINION	OTHER REMARKS	IMPORTANCE
Carrying objects	Domestic	Approved. Useful in case of LLA and MLA, if the user has to remain in the bed.	Carrying objects for household activities was slightly controversial only for the Sweden participants that have underlined the need of more complex activities to be supported, such as defreezing the fridge. Moreover, supporting risky or heavy movements was requested by the users: the mechanical arm capacity has to be extensive for taking objects over the furniture, for example.	Priority
Monitoring the environments and reducing the domestic risks of accident	Domestic	Approved. Useful in case of LLA, MLA and HLA: the users reported that safety from environmental and domestic risks is the most important activity.	With the term "safety" is intended the whole set of activities from surveillance to emergency warnings in case of environmental risk. Moving inside the home during the night has to be strongly supported too, for example, switching on/off the lights when the users is walking.	Priority
Supporting health managements	Domestic	Approved. Useful in case of LLA, MLA and also in HLA: the older people considered this activity important also for their carers.	Among the activities for health management, reminding medicine to take, bringing objects/pills if the user is sick in bed and sending message to the family in case of need are the most required.	Priority
Enhancing social communication and relationship	Domestic	Approved. Useful in case of LLA, MLA and also HLA: the users reported that they will feel more secure if they can be easily connected with their family.		Priority

FUNCTION	CONTEXT	MAIN ELDERLY OPINION	OTHER REMARKS	IMPORTANCE
Reminding tasks and events	Domestic	Approved. Useful in case of LLA, MLA for what concerns mostly the tasks related to health management.	Also in case of HLA, it could be useful for reminding the users to social events and meetings.	Priority
Surveillance	Domestic Condominium	Approved. Useful in case of LLA, MLA and HLA: the users reported that safety and surveillance are the most important activities.	The opportunity of knowing who is at the door was considered really important, both for the users and for their carers.	Priority
Welcome to the visitors	Condominium	Approved. Useful in case of LLA, MLA and HLA.	In any case, this function was considered not so much interesting.	Secondary
Service communication to flat owner	Condominium	Approved. Useful just in case of HLA.	In any case, this function was considered not so much interesting.	Secondary
Going out for a walk	Outdoor	Approved. Useful in case of LLA, MLA. The support to the outdoor can be useful in case of bad weather condition and situation of restricted mobility for a certain period of time. The importance of supporting outdoor mobility was linked with the opportunity of taking part to the social community life.	The outdoor robot is felt as important in enhancing the feeling of security while walking outside, most of all if it can alert the users of obstacles in the path. Moreover, the robot should climb stairs with heavy objects, like shopping bags.	Priority
Social local service information and surveillance	Outdoor	Approved.	In any case, this function was considered not so much interesting.	Secondary
Home shopping service	Condominium and Outdoor	Approved. Useful for LLA and MLA, mostly to support the carers in regaining time.	Shopping activity needs to be refined, connecting user and robot in choosing the right products. Some concerns arose also on how to pay at the shops.	Secondary

FUNCTION	CONTEXT	MAIN ELDERLY OPINION	OTHER REMARKS	IMPORTANCE
Waste collection service	Condominium and Outdoor	Approved. Useful for LLA, MLA. As shopping service, it could be useful for the older people that have difficulties in moving for a certain period.	It would be interesting for the older people if this activity should be done in cooperation with the domestic robot, that can recognize the waste for recycling.	Primary
Home postal service	Condominium	Approved.	In any case, this function was considered not so much interesting.	Secondary

2.3 Potential technical accessories and technology in Robot-Era

Technical opportunities in Robot-Era are very comprehensive due to a consortium of well experienced and equipped partners. At the actual status of the project the technically oriented work packages are discussing how structuring the platforms according to services and requirement requested by elderly persons. Nonetheless some of the potential technical functions and modules are listed afterwards:

- Mobile platforms for indoor and outdoor use
- Autonomous and safe navigation via laser and infrared sensors
- Manipulation via robotic arm and gripper
- Wide Area Network and Internet access (allowing e.g. data, audio and video connections)
- P2P communication
- Various input modalities:
    - Teleoperation / Remote Control
    - Camera
    - Speech Control via microphone and speakers
    - Tablet Computer with Touchscreen
    - Gesture control via Kinect

From users point of view some more modules and requirements might be interesting and could be integrated into the platform, such as:

- Video projector
- Cleaning devices (e.g. vacuum cleaner)
- GPS tracking
- Water or medication dispenser
- Quiet navigation and operation
- Ability to go through difficult terrains (outdoor robot; e.g. sand, lawn).

3 Evaluation of functions

Not all functions identified in D2.1 can be realised in Robot-Era. If the main aim is to develop a system of robotic services which can really be marketed, the consortium needs to focus on functions that end users and caregivers necessitate and that care facilities and insurances would really pay for. Thus, during Task 2.3 in order to shed light on the structure of services / functions to be realised, particular two kinds of investigations were carried out:

- a creative workshop with care institutions, professional care staff and inhabitants of a professional care facility in Germany;
- two focus groups with stakeholders and caregivers in Italy.

3.1 Workshop with Care Facility in Berlin

3.1.1 Aim

The workshop aimed at the evaluation of already identified functions / services from care facilities and their residents point of view. The main focus was to choose the functions that a care facility would really benefit from and thus might pay for. The workshop was carried out on 11th of May 2012 took about 3 hours.

3.1.2 Participants

The workshop was held with 11 participants (6 seniors living in the care facility, with 3 of them male and aged 84, 84 and 86, and 3 female aged 58, 92 and 73; and 5 caregivers/service personnel, 1 of them director, 2 supervisers and 2 care staff) in a care facility in Berlin.

3.1.3 Schedule of Berlin Evaluation Workshop

The workshop consisted of four parts:

1) Introduction
2) Collection of service ideas (Method: Brainwriting)
3) Evaluation of service ideas (Method: Simplified Scoring Method)
4) Discussion of service ideas (Method: Contextual Inquiry)

1) Introduction
The first part of the workshop included:

- presentation of state of the art in robotics (Robots from projects ALIAS, Care-O-Bot and Paro)
- definition of workshop aims
- introduction of schedule and ourselves

2) Collection of service ideas (Method: Brainwriting) (Figure 1)
The aim of this module of the workshop was obtaining the care facility staff and residents opinions about the following aspects:

Questions for care staff:

- Which functions should a robot have to support your work?
- Which tasks should not be substituted by a robot?
- Which processes consume a lot of time or bother you?

Questions for patients / residents:

- What do you want a robot to do?
- Which tasks that you do together with your carers should not be substituted by a robot?
- Which social activities might be supported by a robot (gaming, communication, movies etc.)?

Figure 1 On picture of the part 2) of workshop in Berlin (Germany)

The method "Brainwriting" [5] was carried out during the workshop following these steps:

1. Workshop supervisor introduces the issue and separates participants into 4 groups (2 groups of carers, 2 groups of inhabitants), each one including 3 persons.
2. Every participant gets a form with one question. The participant writes down solutions/answers to this question. Especially when older elderly needed help, one of supervisors wrote down their notes.
3. The form is passed on to one's left-hand neighbour after about 3 minutes.
4. Every participant refines the ideas on the form or adds new answers.
5. Repeat steps 3 and 4 until everyone has their own form back.
6. Solutions may be discussed.

3) Evaluation of service ideas (Method: Simplified Scoring") (Figure 2)
This method aims to evaluate the importance of already identified functions from D2.1.

Figure 2 Pictures relative to the third part of the workshop in Berlin (Germany)

The Method "Simplified Scoring" can be described as follows:

1. A list of about 20 main functions is described to the participants by the workshop supervisor
2. Every participant receives 6 glue dots (3 green for liked functions; 3 red or yellow for disliked functions)
3. The participants stick their dots to specific functions they particularly like or dislike
4. Dots are count for evaluation

4) Discussion of service ideas (Method: Contextual Inquiry)
The main objective of this investigation tool is finding out the most feasible and important tasks to be fulfilled by robots in care facilities.

Method "Contextual Inquiry" [6], [7] was executed in this way:

with three groups (mixed of staff and inhabitants) typical tasks in the care facility (Group 1: Logistics; group 2: personal care; group 3: organization) have been traced by walking slowly through a part of the facility and letting the groups explain/discuss the processes that take place in these parts. During the discussion, questions like "What tasks are annoying or physically strenuous?" or "During which tasks are you communicating a lot with inhabitants?" are considered to find out, which tasks might be substituted by a robot.

3.1.4 Results

Services / functions:
The evaluation of the services identified in D2.1 matches very well with the final judgements described in D2.1 as well.
The home shopping and home postal service have been considered as less important, since both could be substituted by services from companies selling grocery or delivering mail. The other services such as carrying objects, reminder functions, safety and surveillance and social interaction have been evaluated as very interesting.

On the one hand, regarding care services, the workshop results show clearly a dislike against an exertion of primary care tasks by robots (e.g. showering, injections). On the other hand, staff as well as residents like the idea of using robots for very time consuming tasks such as logistics, waste management, and documentation of care, because this might allow carers to spend more time with their patients.

The methods "brainwriting" and "contextual inquiry" identified some missing functions: information and entertainment, the management of patient data and the support of rehabilitation or prevention activities.

Cost benefits / Willingness to pay:

Particularly the staff of the care facility underlines the importance of the efficiency of services provided by the robot. To make public and private service providers willing to pay, a clear calculation has to prove cost benefits. Thinking to the possible buyers of these robotic services, the workshop pointed out that private buyers can have difficulty in directly purchasing this kind of services but they are economically accessible to public and private service providers. Some examples of possible advantages for service providers:

- Cost benefits for insurances:
    - Management of patient data reduces organizational costs
    - Support of prevention activities reduces risks of diseases
    - Support of rehabilitation activities reduces costs and duration of rehabilitation

- Cost benefits for municipalities and care facilities:
  - Automated waste management reduces costs
  - Surveillance improves safety
  - Automated food supply reduces costs and improves convenience

These considerations are important also for the researches carried out in WP9 so they will be used also in this other part of Robot-Era project.

3.2 Focus group with Italian Caregivers

3.2.1 Aim

The aim of the Italian focus group with carers was the analysis of the functions and services of the platform to be implemented, in order to give adequate support for the care giving activity. The importance of taking into consideration the caregivers perspective is due to the fact that they are considered not only secondary end-users of a technological device for their assisted elderly, but also mediators of the learning process and the acceptance of the device by the elderly. Supporting the carers with new technological solutions for regaining time, enhancing their health status and facilitating the cooperation with formal caregivers and available services are considered key priorities of the research in the field.

3.2.2 Participants

The group of participating caregivers was composed of 12 caregivers, of which 10 were female and 2 were males reporting 55-60 years. Five caregivers live with the elderly while the other seven subjects provide care the elderly for few hours a day.

3.2.3 Schedule

After the project presentation, the same videos shown to the older people during Task 2.1 were presented to the carers. Then, the group discussion was divided into the following areas:

1) General impression on the robotics and on the Robot-Era platform;
2) Type of assistance given to the elderly;
3) Caregivers' needs to be supported by the Robot-Era platform;
4) Ideal target of the Robot-Era platform;
5) Technology acceptance: barriers to the use;
6) Closing questions: suggestions and remarks.

The detailed questions were reported in the Table 2.

Table 2 Detailed overview of questions submitted during the first focus group in Ancona (Italy) with caregivers. The acronym "RE" means "Robot-Era".

TOPIC	KEY WORDS	QUESTIONS
General impression	Innovation, usefulness	1. Do you think RE could be useful for the assistance?
Assistance	Support, work, time spent in assistance	2. What kind of assistance you give to your elderly person and for how many hours? In which activities?
Needs	Unsolved needs, time to regain,	3. How are the major difficulties you have encountered during the assistance?

TOPIC	KEY WORDS	QUESTIONS
	integration with formal services	4. The RE platform, could be a valuable support for the assistance? In which way? 5. Which activities can be supported and which activities are missing, in your opinion? 6. If you have had a support, such as a migrant care worker, do you think that could be substituted or integrated with the RE platform?
Target	Age, impairment, living alone, old carers, gender	7. What kind of older people can used the RE platform? And carers?
Technology acceptance	Training, mediators, sustainability	8. Which factors could create resistance in your decision of using a robot for supporting the care giving?
Closing questions		9. Suggestions and remarks for the developers.

3.2.4 Results

The participants have shown a positive attitude towards the Robot-Era platform as well as the technology itself and they really have appreciated the idea of a robot for helping their family in case of need. Moreover, they were very curious to know how the robot works in indoor and outdoor contexts. According to caregivers, the robot is certainly innovative and for them the most important functions could be: **bringing medication to the elderly people** and **calling them in case the older person feels sick.**

The possibility of **communicating** with the family is very important, in particular, for the elderly persons that live alone. In case of need or accident, the robot could call or send a message on the caregiver's phone. This function would save time in case of emergency and the caregiver would feel safer to leave the elderly alone at home for a few hours.

Moreover, if the robot could be integrated with other existing technologies, such as a **video camera**, it would be more complete. In this case, the caregivers could check from remote what happens into the apartment of the elderly as a continuous monitoring.

The function of **bringing medicines** is very useful but the robot should be able also to check if a medicine was really taken, considering that the elderly people have to take many medicines at any time.

For this reason, it is necessary a highly customization of the robot, as it would know when and what kind of medicine the elderly have to take.

Moreover, the robot could also be used **in hospitals to distribute medicines** in the wards. This function could help the staff to do their tasks and could guarantee savings from the point of view of personnel management.

The majority of the suggestions given by carers are on the physical requirements of the robot: the robot could be helpful in some activities at home, but it should have an extendable arm for **taking objects** over the furniture and to reach the top; it should **climb the stairs with heavy objects**, reducing domestic accidents and the risk of falling at home. Furthermore, it would be useful if the robot could **bring objects** as well as **lift objects up to 5 kilograms**, for example bottles of water.

For the participants, the robot cannot substitute the caregiver in case of a serious loss of

independence, but it should be an integration of the assistance, because elderly needs human contact to not feel alone.

The robot could have also **social and recreational functions**. Becoming older, someone could have vision problems so a robot could **read a book** for him/her and could be very useful just to spend the time.

Another important feature for the robot is that it would be able to **lift and move the person out of bed**, considering that the caregivers are mostly middle-aged women.

Moreover, another function that the indoor robot could make is to sustain people with problems of mobility, in particular during the night, for example **taking elderly to the bathroom** and **turn on/off the lights**.

The feature of the **surveillance** is very interesting; if the robot could be able to **open the door** only to familiar people, the caregivers would feel safer. This could be reached through **voice recognition**, the imprint of the finger, password or photos.

They all agree that the outdoor and indoor robots should be able to **climb stairs** because many apartments do not have an elevator. To fill this gap, they could use an elevator like, for example, those used for the disabled wheelchairs or they could equip the robot to climb the stairs.

About the outdoor robot, they think that the robot could be useful when the elderly cannot get out to shop such as in a period of disability or flue.

In fact, although the robot is not able to cook, the caregiver saves time because the robot can do **shopping** instead of him/her.

Moreover, the participants stated that they would prefer having a robot for a few hours and for some activities rather than a migrant care worker, for reducing the cost of the assistance: if there is a robot, the carers would trust to leave the elderly alone, and the robot could **bring water, medicines or objects**, reducing the time of activity of the migrant care worker.

Moreover, a migrant care worker should be seen as an "intruder" especially by older women, while with a robot, they would experience more sense of independence. On the contrary, for older men the presence of a migrant care worker could be easily accepted, as they have often difficulty in doing some household activities.

Among the factors that could create resistance to the use, the cost and the difficulty in using the robot are the most important ones. All participants of this focus group agree that the robot functions should be easy to use and that the robot should be not too big for their flat. Moreover, if possible, it has to look nice, to have a human aspect, and looks like a woman.

The ideal target of the robot should be constituted by older person with some problems in the functional status and with mild cognitive impairment.

For the carers, the robot could be integrated with the technologies already available in the local area, such as the telemedicine services offered by some hospitals.

3.3 Focus group with Italian stakeholders

3.3.1 Aim

The aim of the second focus group with Italian stakeholders is to understand the role of the Robot-Era platform inside the local services and the activities that could be a useful support, for example, for saving time and resources. Moreover, the experience of the stakeholders

and professionals was useful for exploring the older people needs, in case of health and social problems and the most relevant issues to answer to.

3.3.2 Participants (stakeholders)

The group of stakeholder was composed of 12 persons: a geriatrician, a physiotherapist, two social workers, two researchers, two engineers, a sociologist, a scientific director, a responsibility of clinical activities and a president of a Italian voluntary association for the elderly (called AUSER).

3.3.3 Schedule

After the project presentation, the same videos used for the first focus group were presented to the carers. Then, the group discussion was divided into the following areas:

1) General impression on the robotics and on the Robot-Era platform;
2) Older people needs;
3) Ideal target of the Robot-Era platform;
4) Technology acceptance: barriers to the use;
5) Closing questions: suggestions and remarks.

The detailed questions were reported in Table 3.

Table 3 Detailed overview of questions submitted during the second focus group in Ancona (Italy) with stakeholders. The acronym "RE" means "Robot-Era"

TOPIC	KEY WORDS	QUESTIONS
General impression	Innovation, usefulness	1. Do you find RE useful or innovative on the care side? 2. And on the technological side?
Needs	Unsolved needs, integration with formal services	3. What are, in your opinions, the most relevant unsolved needs of the older population? 4. RE platform could give an effective support for your work? In which activities? 5. On the technical side, what are the main functions to be implemented?
Target	Age, impairment, living alone, old carers, gender	6. What people can be able to use RE? 7. In which context can be used the platform, i.e. at home, care facilities… 8. The quality of the assistance given by the RE platform is appropriate? 9. How can be adapted the interfaces, in the basis of the target you proposed?
Technology acceptance	Training, mediators, sustainability	10. Which services can be supported with the robots? 11. What is the role of the carers in the decision of using a new technology for the assistance? 12. Which factors could create resistance in the decision of using RE platform for the assistance?

TOPIC	KEY WORDS	QUESTIONS
Closing questions		13. Remarks and suggestions for the developers.

3.3.4 Results

From the focus group with the Italian stakeholders, different opinions concerning the robot emerged.

The participants expressed their overall interest in the Robot-Era platform, considering robotics a valuable support for elderly people, but they also suggested that the robot should be an **integration of the formal/informal assistance** received by devoted carers and not a substitute of them.

Even if the robot represents a useful support for certain activities, it is necessary to identify specific functions and tasks that can be done just with the robot and not with other affordable technologies. In fact, basic simple products are already available in the market at a more accessible costs and lighter environmental impact. The overall suggestion of the stakeholders was to develop simple functions that can be done just with the robot, as the ones regarding the **mobilization of the older people** confined in bed, for example.

One issue to be considered in using a robot inside the home is the presence of architectural barriers inside the apartments of the elderly and the cost that could be spent for re-adapting them, in case a robot has to move inside. For this reason, it was suggested to consider the opportunity of using one robot for more users, for example in equipped areas of the town or in special buildings and apartments developed for not complete self-sufficient people.

As reported before, **mobility** is considering the most important area that can be supported just with the robotics, due to the fact that nowadays there are not complex technologies able to do that.

On the technical side, it was suggested that the robot could be able not only in distinguishing and **bringing objects**, but also in managing them for compensating the decreased dexterity of the older people, for example **opening a bottle**.

One problem that they have reported is the way in which the robot would distinguish the objects: it should distinguish the objects by dimension, shape and weight, but in particular by content.

In any case, the platform was considered a concrete support for the health services: the robot could be purchased not only privately by the elderly, but also by public health services that could make it available to those who really necessitate it, even for a short period of time, giving priority according to user needs. In this way, it could reduce waiting list for elderly looking for the help of a physical person and it could help the elderly with physical impairment, for example in **doing shopping** and making other **household activities**.

According to stakeholders, there are many frail elderly that live alone, that are assisted by specialized socio-medical team at home: the robot could support the team in some activities, for example closing a drip, saving time for the assistance considering the limited resources.

Moreover, the robot could help the elderly not only in care activities, but also for remaining active and continuing to work, supporting them in heavy works.

In general, the stakeholders shown a positive attitude towards the Robot-Era platform, reporting that such technology can likely improve care: the robot have great potentialities and could really help not completely self-sufficient people that live alone, with nor or slight cognitive impairment.

4 Robot-Era service structure

Hereafter a first structure of service to be realized in Robot-Era will be described. This structure takes into account the results of evaluation workshops and focus groups described in chapter 3 of this document. It is a preliminary results that will be refined and detailed in the next work of Task 2.3. On the one hand, not necessarily all functions will be taken into account (e.g. due to technical difficulties or due to changing market situations), on the other more functions might be added later during the project.

At first, structural influences are described. Secondly the structure is presented graphically and functions are described shortly.

4.1 Criteria for structuring services

Several different means may be used to structure the services a robot should deliver. Since the users on the one hand and the robot on the other are the most important influences of the "robotic work system", these factors should be used for structuring Robot-Era services.

4.1.1 User point of view: Level of autonomy and needs

The functions and services needed depend mostly on the autonomy of a user. Levels of autonomy have been described already in the proposal of the Robot-Era project:

High Level of User Autonomy (HLUA)
The HLUA is associable to end-users that; 1) have not particular deficits or limitations from either motor or cognitive point of view, and 2) their medical providers suggest that they should be active and should execute IADLs autonomously as much as possible. The necessity to use a robotic service is due to soft and transitory motor or cognitive impairments, such as cold, tiredness, etc., and possible environmental and contextual conditions, such as adverse weather or other commitments of the end-user, etc.

Middle Level of User Autonomy (MLUA)
The MLUA is characterized by elderly people with slight motor limitations of the upper or lower limbs and can carry out most of daily tasks but in some cases they need support. Environment conditions can be potentially difficult (e.g. wet soil, hot weather, street traffic). End-users can also have impediments or commitments that necessitate further help from robots to execute these tasks quickly and correctly.

Low Level of User Autonomy (LLUA) / Relevant for care institutions
The LLUA is characterized by elderly persons having motor limitations or provisional bad health status such that they cannot move too much and need help to carry out IADLs. The LLUA context can also be caused by unfavourable environmental conditions.

To deal with various levels of autonomy, Robot-Era platforms should provide various services and also should execute task in different way according to the specific characteristics of the users. The impact of these services for the users is also related to the type of interaction between robot and user required during the services; in particular four levels of interactions can be distinguished, as described in detail in D2.1:

- *Level 0:* Only communication (e.g. medication reminders, alarms, monitors)
- *Level 1:* Robotic platform can move but avoids physical contact with user (e.g. autonomous vacuum cleaners)

- *Level 2:* Robot shares some operating space with the user (e.g. robots for domestic activities support)
- *Level 3:* Robotic platform having physical contacts with the users during its task (e.g. rehabilitation devices, wheelchairs, powered walking aids).

Furthermore previous researches in the social and gerontology fields and the focus groups and workshop carried out till now during the Task 2.3 shown that the needs of elderly could be divided in five main domains (see Table 4).

Robot-Era services should reflect and be associable to these main needs domains that are shown in Table 4.

Table 4 Needs' domain

Needs domain	Activities of the Robot
Personal care and household activities	Carrying objects, monitoring the environment, reducing domestic risk of accidents, waste collection, communication to the flat owner, surveillance
Well-being, overall health	Management of the health condition
Freedom to go wherever desired	Assistance when going out, bringing objects, social local service information, maps, home shopping service, home postal service.
Participation in desired activities	Reminding task and events
Family relationships, emotional well- being	Enhancing relationships with relatives, friends, welcome to visitors

4.1.2 Robots point of view: Indoor, Condominium and Outdoor environments

In Robot-Era project the consortium partners will develop three kinds of robotic platforms:

- Indoor / domestic platform
- Condominium platform
- Outdoor platform.

Since these platforms will be used for different tasks, they will also be prepared with different modules and functionalities. The pictures below, taken from the proposal, describe main components and give an impression of potential designs of the three types:

4.1.3 Service Areas

The services related to elderly daily needs can be divided in six main areas:

- Social interaction
- Information
- Safety
- Health
- Leisure
- Physical support.

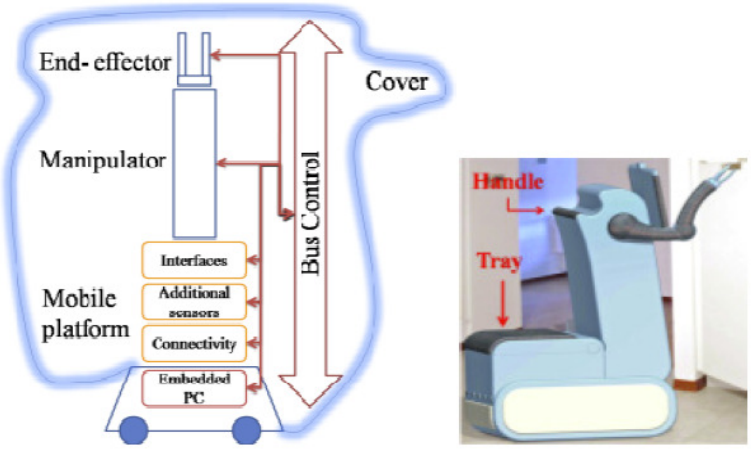

Figure 3 High level overview of the main components integrated in the domestic / indoor robotic platform (left). A preliminary example of the cover of the domestic robot with handle and tray (right)

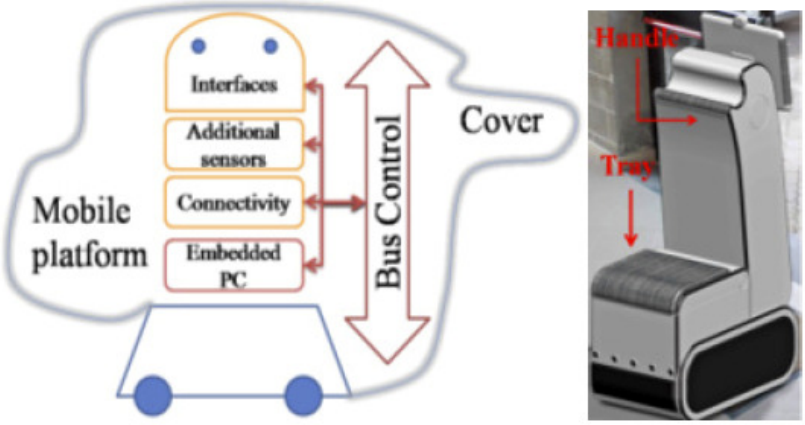

Figure 4 High level overview of the main components integrated in the condominium robotic platform (left). A preliminary example of the cover of the condominium robot with handle and tray (right)

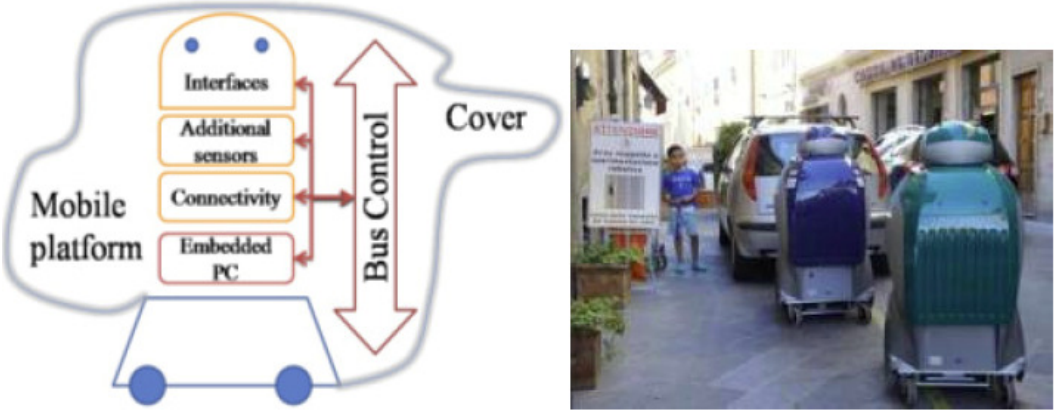

Figure 5 High level overview of the main components integrated in the outdoor robotic platform (left). The DustCart robotic platforms provided by RT (right)

4.2 Graphical Overview of Services

To better clarify how the levels of user autonomy and the working environments of Robot-Era robots should influence the service structure, two graphics (Figure 6 and Figure 7) were developed to summarize services identified till now in Task 2.3.

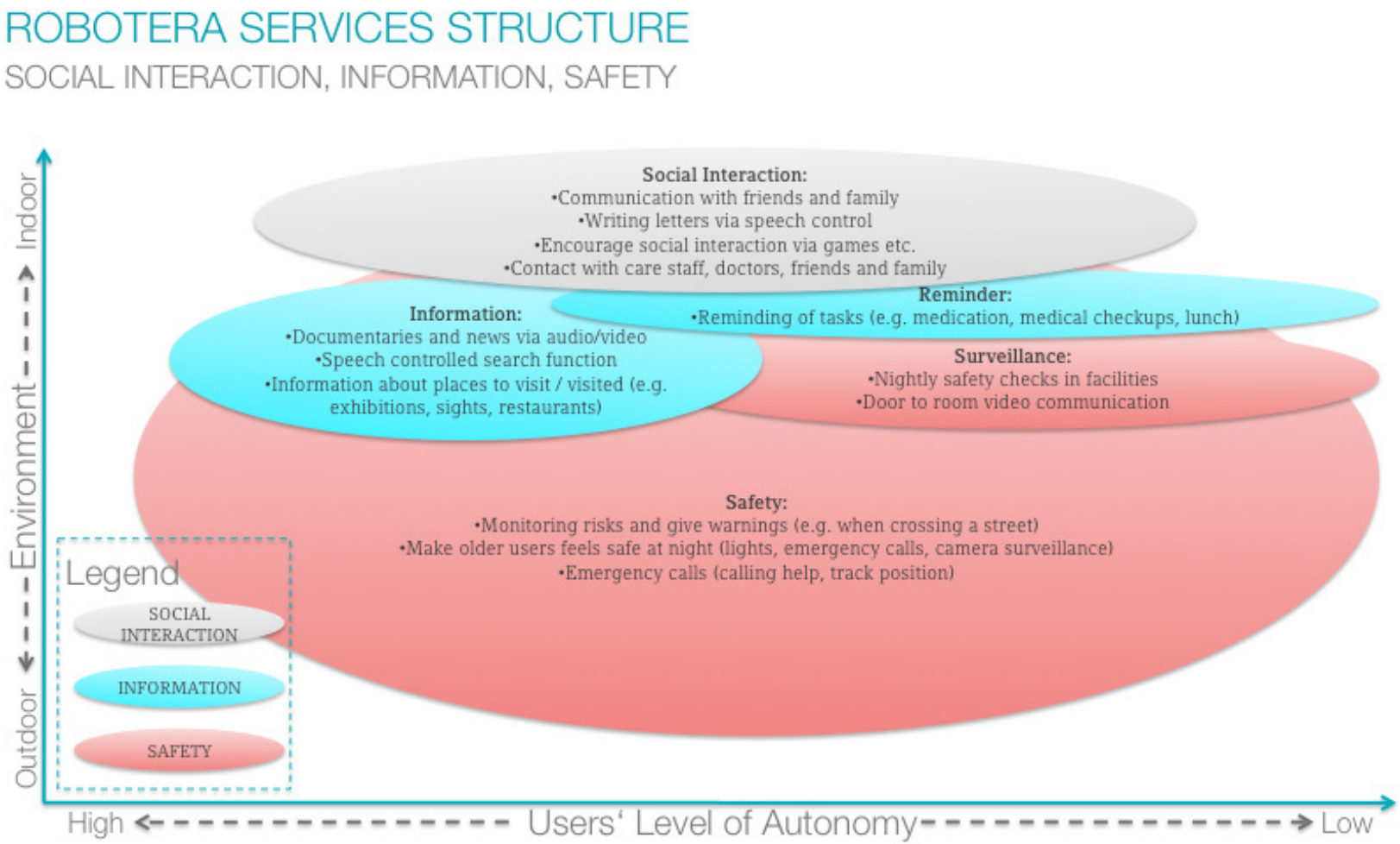

Figure 6 Overview of services relative to the areas "Social Inclusion", "Information" and "Safety"

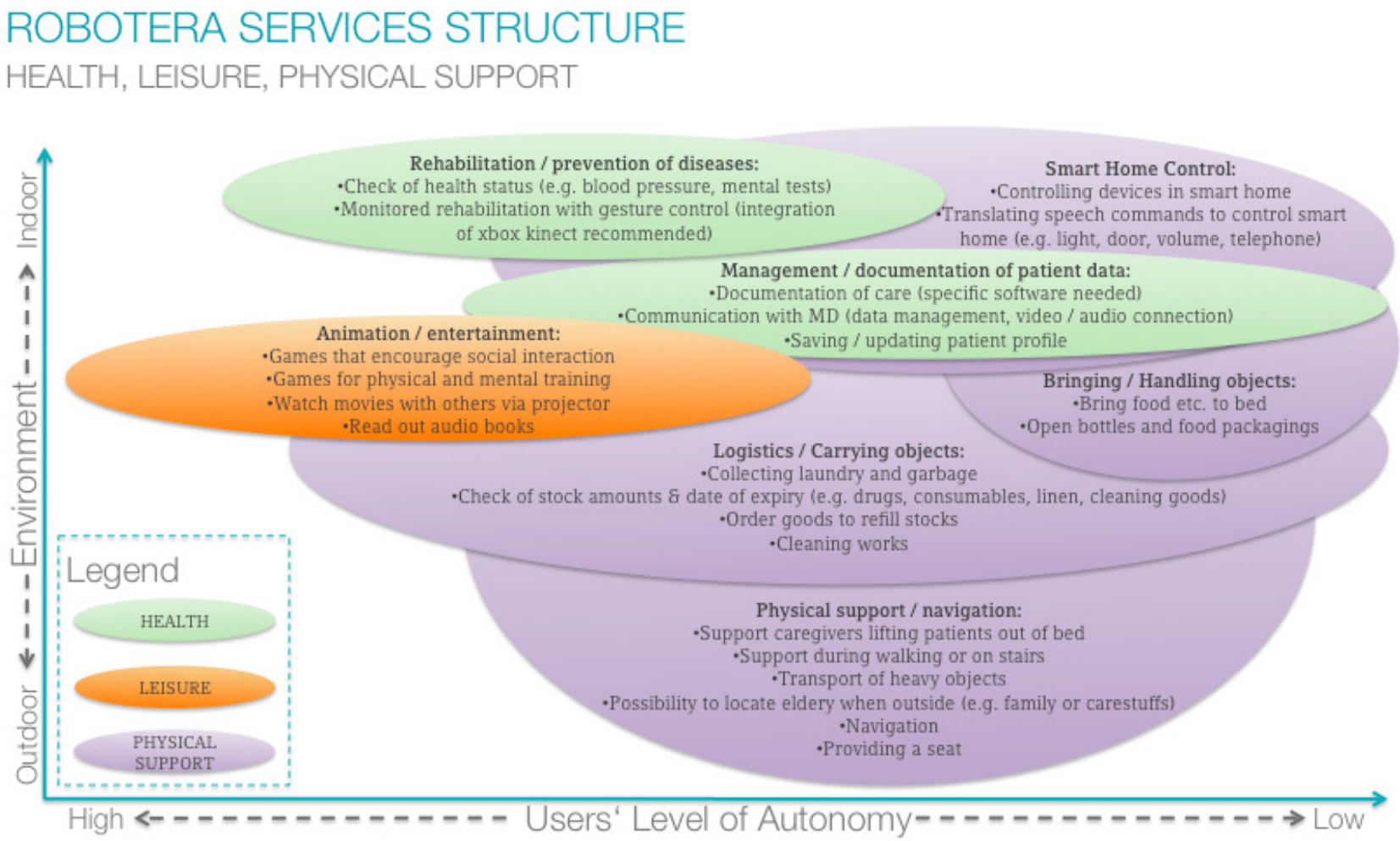

Figure 7 Overview of services relative to the areas "Health", "Leisure" and "Physical Support"

4.3 List of selected functions

The following tables (Table 5, Table 6, Table 7, Table 8, Table 9 and Table 10) describe the selected service areas (separated by the same background colours used in the graphical overview in chapter **Errore. L'origine riferimento non è stata trovata.**) and the associated services identified till now in Task 2.3.

The feasibility of the mentioned services was discussed with all Robot-Era Consortium thinking to the research context of Robot-Era project.

Table 5 Proposed services related to the "Health" area

SERVICE AREA	SERVICE	ACTORS	DESCRIPTION	OPEN QUESTIONS
Rehabilitation and prevention of diseases	Check of health status	Indoor robot; Elderly user (HLOA, MLOA); Caregiver or Medical Doctor (MD) to receive results	• Blood pressure check • Mental tests • Blood glucose	• Connection with external health measuring devices possible (e.g. blood pressure meter, scale)
	Monitored rehabilitation with gesture control	Indoor robot; User to do rehabilitation exercises (HLOA, MLOA)	• Digital trainer for rehabilitation exercises • Monitoring of correct execution by gesture control	• Integration of kinect for gesture control recommended • Software to monitor rehabilitation is researched in other projects and should be available
Management and documentation of patient data	Documentation of care	Indoor robot; Caregiver to document care process	• Documentation of care process via speech dialogue	• Specific software needed, but already available on market

SERVICE AREA	SERVICE	ACTORS	DESCRIPTION	OPEN QUESTIONS
	Communication with MD	Indoor robot; User (HLOA, MLOA, LLOA); MD; Caregiver to make a health report or to pose questions to MD	• Caregiver lets robot make a report (including audio / video) and sends it to MD, who might check and answer when he is available • User consults MD from home	• Video / audio connection to be used
	Saving and updating patient profile	Indoor robot; User to check health (HLOA, MLOA); Caregiver to add information to profile; MD to check profile when necessary	• First setup of user profile at first encounter with robot • Integration of health information taken from other modules like rehabilitation or check of health status • Integration of caregivers comments • Easy to use interface for MD	• Integration with IT systems at MD recommended

Table 6 Proposed services related to the "Physical Support" area

SERVICE AREA	SERVICE	ACTORS	DESCRIPTION	OPEN QUESTIONS
Logistics and carrying objects	Collection and distribution of laundry and garbage	Indoor robot; Condominium robot; Outdoor robot; User to give additional instructions (HLOA, MLOA, LLOA); Caregiver to give additional instructions	• Collection, transport and unloading of garbage indoor and outdoor • Collection, transport, unloading and distribution of laundry, linen etc. indoor and outdoor • Setup function to explain robot where to collect waste or laundry	• At least one arm necessary
	Check of stock amounts & date of expiry	Indoor robot	• Count amount of e.g. drugs, consumables, linen, cleaning goods • Check date of expiry of e.g. drugs and food	• RFID tags necessary to check date of expiry

SERVICE AREA	SERVICE	ACTORS	DESCRIPTION	OPEN QUESTIONS
	Order goods to refill stocks / online shopping	Indoor robot; condominium robot; User to receive goods or add orders	• Order goods to refill stocks in facilities or in refrigerator e.g. when stocks are empty or when products have expired • if necessary: receive goods at door and transport to stocks or user	• Integration of home shopping service or drug delivery service necessary
	Cleaning works	Indoor robot; Condominium robot	• Hovering • Wiping • Cleaning windows	• Integration of vacuum cleaner or connection with automated vacuum cleaner possible • For cleaning windows expandable arm necessary
Mobility and Navigation	Support caregivers lifting patients out of bed	Indoor robot; Condominium robot; User (LLOA); Caregiver	• Support caregiver when relocating patients	• Robot would need high stability • Robot would need resilient arms
	Support during walking or on stairs	Indoor robot; Condominium robot; Outdoor robot; User (MLOA, LLOA)	• Support user by giving him / her hold • React to users commands regarding speed	• Robot would need high stability
	Transport of heavy objects	Indoor robot; Condominium robot; Outdoor robot; User (HLOA, MLOA, LLOA) to give commands; Caregiver to give commands	• Loading and unloading of heavy objects onto robot (e.g. crate of water) • Transporting heavy objects	• Robot would need high stability • Robot would need resilient arms

SERVICE AREA	SERVICE	ACTORS	DESCRIPTION	OPEN QUESTIONS
	Possibility to locate elderly when outside (e.g. family or carestuffs)	Indoor robot to locate user; Outdoor robot to be located; Caregiver to initiate location via indoor robot	• Outdoor robot can be located via GPS • Indoor robot allows caregiver to locate outdoor robot (interaction via speech and displayed map)	• Outdoor robot needs GPS
	Navigation	Indoor robot; Condominium robot; Outdoor robot; User (MLOA, LLOA)	• Robots can navigate independently without crashing • Outdoor robot can navigate user to specific places, sights or back home	• Outdoor robot needs GPS
	Providing a seat	Outdoor robot; User (MLOA, LLOA)	• Robot can swing out a seat for user (e.g. for rest during longer walks)	• Robot would need high stability
Bringing and handling objects	Bring and moving goods inside house	Indoor robot; User (LLOA)	• Robot searches goods when ordered • Robot brings goods (food, drinks, newspaper etc.) to specific place (i.e. bed) when ordered	• Goods need to be RFID tagged to be found by robot
	Open bottles and food packages	Indoor robot; User (MLOA, LLOA)	• Open bottles and food packages	• Two arms necessary
Smart Home Control	Controlling devices in smart home	Indoor robot	• Control devices (e.g. light, door, telephone, windows, air condition, entertainment) via data connection	• Data connection to smart home devices necessary
	Translating speech commands to control smart home devices	Indoor robot; User (HLOA, MLOA, LLOA)	• Allow speech dialogue with user to control smart home devices (e.g. light, door, telephone, windows, air condition, entertainment) via data connection	

Table 7 Proposed services related to the "Leisure" area

SERVICE AREA	SERVICE	ACTORS	DESCRIPTION	OPEN QUESTIONS
Animation and entertain-ment	Games that encourage social interaction	Indoor robot; User (HLOA, MLOA)	• Multiplayer games for online gaming and for use with several persons at one robot	• Integration of online gaming services possible
	Games for physical and mental training	Indoor robot; User (HLOA, MLOA, LLOA)	• Mental challenging games such as chess, Sudoku • Physical challenging games with gesture control (such as kinect adventure games)	• Integration of kinect necessary
	Watch movies	Indoor robot; User (HLOA, MLOA, LLOA)	• Show movies either on screen or via video projector to watch together with other • Use movies on demand services to ensure wide selection • Allow speech and touchscreen control	• Integration of video projector or data connection to video projector necessary • Connection to movies on demand portal necessary • Can be combined with "watch documentaries and news" function (information)
	Sing together	Indoor robot; User (HLOA, MLOA, LLOA)	• Sing together with users • Use songs from online portals to ensure a wide selection (particularly oldies)	• Connection to itunes or similar service necessary

SERVICE AREA	SERVICE	ACTORS	DESCRIPTION	OPEN QUESTIONS
	Read out audio books	Indoor robot; User (HLOA, MLOA, LLOA)	• Read out audio books (e.g. to support falling asleep) • Use audio books from online portals to ensure a wide selection	• Use electronic audio books from specified services • Maybe add a scan to text to speech function for reading out printed texts (technology already available)?

Table 8 Proposed services related to the "Social Interaction" area

SERVICE AREA	SERVICE	ACTORS	DESCRIPTION	OPEN QUESTIONS
Social Interaction	Communication with friends, care staff, doctors and family	Indoor robot; User (HLOA, MLOA, LLOA)	• Speech controlled communication via video, audio (Skype) and e-mail • Option to switch video on/off	
	Writing letters via speech control	Indoor robot; User (LLOA)	• Speech to text function • Option to send via e-mail or to print out and send as letter	• If applicable connection to printer
	Encourage social interaction via games etc.	Indoor robot; User (HLOA, MLOA)	• Motivate user to play together with others (e.g. other residents of care facility or other online players) • Facilitate matching with other users with same gaming interests • Facilitate organization of gaming events (e.g. in care facility or assisted accommodation by asking residents to select a preferred activity for the evening)	• Profiles of several users have to be saved • Integration of scheduling tools like doodle necessary

Table 9 Proposed services related to the "Information" area

SERVICE AREA	SERVICE	ACTORS	DESCRIPTION	OPEN QUESTIONS
Information	Documentaries and news via audio/video	Indoor robot; User (HLOA, MLOA, LLOA)	• Show news and documentaries either on screen or via video projector to watch together with other • Use online services of TV stations to ensure wide selection • Allow speech and touchscreen control	• Integration of video projector or data connection to video projector necessary • Connection to online services of TV stations necessary • Can be combined with "watch movies" function (leisure)
	Speech controlled search function	Indoor robot; Outdoor robot; User (HLOA, MLOA, LLOA)	• Allow free search via speech input give answers via speech and/or screen output	• Integration of Google or similar search portals necessary • Particularly important for indoor robot
	Information about places to visit (e.g. exhibitions, sights, restaurants)	Outdoor robot; User (HLOA, MLOA, LLOA)	• Search places to visit when being out for a walk • Navigate to selected places	• Particularly important for outdoor robot • Integration with navigation function
	Reminding of tasks	Indoor robot; User (HLOA, MLOA, LLOA)	• Reminder function (e.g. for medication, medical checkups, lunch, birthdays)	• Integration with Google calendar or similar service • If applicable integration with health status checkups, communication functions and navigation functions

Table 10 Proposed services related to the "Safety" area

SERVICE AREA	SERVICE	ACTORS	DESCRIPTION	OPEN QUESTIONS
Safety	Monitoring risks and give warnings	Indoor robot; Outdoor robot; User (MLOA, LLOA)	• Monitor internal risks (e.g. health status of user, slips and falls) • Monitor external risks (e.g. traffic, red traffic lights, tripping hazards)	• Integration of external health monitoring devices necessary
	Make older users feels safe at night	Outdoor robot; User (HLOA, MLOA, LLOA)	• Reduce the risk of being robbed or attacked by illumination and camera surveillance	
	Emergency calls	Indoor robot; Outdoor robot; User (MLOA, LLOA); Caregiver or call center to receive emergency call and to remote control robot	• Enable emergency calls initiated eighter by buzzwords (e.g. "help"), by camera or by external monitoring devices (e.g. measurement of blood pressure, acceleration sensor) • Allow remote control combined with video surveillance and audio connection in emergency situations via web interface • Track position in emergency situations • Emit loud sound when being attacked or robbed, initiated by buzzword (e.g. "robber")	• Integration of emergency call service necessary • Emergency call service has to be trained to use remote control
	Nightly safety checks in facilities	Indoor robot; Outdoor robot; User (HLOA, MLOA, LLOA)	• Surveillance of care facilities • Surveillance of property (house, garden, carpark)	

SERVICE AREA	SERVICE	ACTORS	DESCRIPTION	OPEN QUESTIONS
	Door to room video communication	Indoor robot; Condominium robot; Outdoor robot; User (HLOA, MLOA, LLOA)	• Show video of person at door on screen of indoor robot • Take video of person at door by outdoor robot	

4.4 Structure of the main services identified in Task 2.3

After the analysis of functions identified in the preliminary work of Task 2.3 carried out by all Robot-Era Consortium, the main robotic services were identified based also on their technical feasibility. Services that particularly rely on the robots abilities to move independently and to manipulate objects are focused, since these services cannot be substituted by "normal" computers. The prioritized services are:

- Drug and shopping delivery
- Indoor escort at night
- Surveillance
- Laundry support
- Food delivery
- Cleaning
- Communication (video call) with friends, family, caregivers, service providers
- Reminding (of events or taking drugs)
- Garbage collection
- Outdoor walking support
- Objects transportation and manipulation

The details of each service are described in the following tables (from Table 11 to Table 21).

Table 11 Drug and shopping delivery

SERVICE	Drug and shopping delivery
SHORT DESCRIPTION	User has the flu and its relatives are in holiday, so he needs someone who provides her the drug for the flu. or: User wants to have breakfast with a visitor. While preparing breakfast, he realizes, that a bread is missing. So he needs someone to get the bread for him.
HUMAN ACTORS	User, doctor, pharmacist, shop staff
TECHNOLOGICAL ACTORS	AmI, Outdoor robot, Condominium robot, Domestic Robot, indoor sensor network, outdoor sensor network
STAKEHOLDER	Drug shop, Public health-care provider, other shops
INTERACTION BETWEEN ACTORS	• User needs drugs or shopping to be brought to his home. • User tells robot, what exactly is needed. Alternatively a standard purchase list has been defined with the pharmacist or any other shop. In this case, the robot gets just the articles listed on that list. Alternatively the doctor can release the distribution of drugs by sending an inquiry to the robot. • Outdoor robot moves to the shop or pharmacy to receive the goods ordered. Alternatively the goods could be received by the condominium robot directly at the door of users' house or apartment, in case a delivery service run by the shop or the pharmacy exists. • Pharmacist or service person puts goods in basket of outdoor robot. • Robot arranges payment (details to be decided later, e.g. mobile payment as used with smart phones or bank transfer possible) • Robot moves back to user.

	• Outdoor robot hands goods to condominium robot. • Condominium robot brings goods to apartment of user. Alternatively it hands goods to indoor robot. • Indoor robot brings goods to user or to defined place in apartment.
OTHER DETAILS	• This service is mainly related to the transport of shopping bag and drugs, not to the remote selection of goods inside a shopping market • Service competes with delivery services (often offered by grocery stores). • If user is not at home, the condominium robot keeps the shopping bag till user will come back at home • In Ängen pilot site, the service is drug delivery and involves only the domestic robot and the condominium robot because the medical center inside the condominium provides drugs to Ängen elderly • In Peccioli pilot site, both shopping and drug delivery will be provided and will involve all Robot-Era robotic platforms • For the shopping / drug delivery an agreement with storekeepers / pharmacists should be created to activate the service and to pay goods • Mode of payment has to be chosen (e.g. mobile payment as used with smart phones or bank transfer possible)

Table 12 Indoor escort at night

SERVICE	Indoor escort at night
SHORT DESCRIPTION	User wants to go to the toilet at night, but being tired and dizzy, and not wanting to switch on a bright light, this implies a risk to fall. Therefore the robot should accompany the user on his way to the toilet, providing a soft floor light and giving him hold.
HUMAN ACTORS	User, in emergency: call center
TECHNOLOGICAL ACTORS	AmI, Domestic Robot, indoor sensor network
STAKEHOLDER	Call center, emergency personnel
INTERACTION BETWEEN ACTORS	• User needs to go to the toilet at night • User calls robot with relatively soft voice (robot might stay close to bed during the night to make sure to hear user). Alternatively sensor network calls robot when user is about to get out of the bed. • Robot switches on soft floor light. • Robot drives close to bed to provide hold for user (robot might say softly “please grap hold here” and illuminate the handle). • User stands up, supported by handle of robot. • Robot drives slowly to bathroom, so that user keeps hold to the handle. During that the robot illuminates floor. • Robot drives to toilet, giving user hold when sitting down and standing up. • User tells robot when he wants to go back to bed. • Robot drives back to bed slowly, providing hold and floor light. • User gets into the bed. • Robot drives away and waits in corner of room or other predefined place.

OTHER DETAILS	• Demanding service for indoor navigation and obstacle avoidance • Service can save high consequential costs occurring after accidents. This is a good argument to be supported by insurances.

Table 13 Surveillance

SERVICE	Surveillance
SHORT DESCRIPTION	User wants to feel safe at night. The robot can therefore check inside and outside the house for known and unknown persons and release an emergency call when necessary.
HUMAN ACTORS	User, caregiver, in emergency: call center
TECHNOLOGICAL ACTORS	AmI, Outdoor robot, Condominium robot, Domestic Robot, indoor sensor network, outdoor sensor network
STAKEHOLDER	Call center, emergency personnel, care or assisted living facility
INTERACTION BETWEEN ACTORS	• Robot and sensor network check for the presence of known and unknown persons in the building • User and caregiver can activate camera on robot and monitor what is happening in the environment • User and caregiver could ask robot to reach a room or a point of the building and to show what is happening • Robot can send an emergency call when recognizing a break-in • Robot can emit a loud emergency sound to cast out not authorized persons
OTHER DETAILS	• Service can save costs for safety personnel. Thus it might be interesting for institutions running a facility.

Table 14 Laundry support

SERVICE	Laundry support
SHORT DESCRIPTION	In care or assisted living facilities as well as in accommodations where washing machines are located outside the apartments, the laundry has to be carried from users apartments to the laundry room. This is time consuming and can be physically demanding. Thus, the robot could pick up the laundry at users' apartment, carry it to the laundry room, put it into the washing machine, activate the machine and carry the laundry back to the user.
HUMAN ACTORS	User, if necessary: service personnel
TECHNOLOGICAL ACTORS	AmI, Condominium robot, Domestic Robot, indoor sensor network
STAKEHOLDER	Manufacturer of washing machines, care or assisted living facility
INTERACTION BETWEEN ACTORS	Logistics • User puts laundry to a defined place in his apartment • User calls robot to pick up the laundry • Robot picks up laundry (piece by piece to not exceed capabilities of arm) and stores it in a transport basket in its body. Alternatively domestic robot picks up laundry and stores it in a basket on the condominium robot. • If necessary: Domestic robot transfers laundry to condominium robot

	• Robot brings laundry to laundry room Washing Process (might be excluded) • Robot opens washing machine with its arm. Alternatively it opens the (network ready) washing machine by sending a signal. • Robot transfers laundry into washing machine. • Robot closes washing machine • Robot selects predefined program and starts washing machine • Robot returns to other activities or waits until laundry is ready • Robot opens washing machine Logistics • Robot transfers laundry into basket • Robot carries laundry either to dryer (and uses it) or to users' apartment
OTHER DETAILS	• Service competes with laundry-full-service providers. • Logistics process is much more important than washing process. • Washing process often conducted by external services. • Service can save costs for service personnel and reduce physical strains. Therefore it might be interesting for care and assisted living facilities. • Both domestic robot and condominium robot should have a basket to carry the items of clothing • Opening washing machine might be difficult for robot. Thus, a network ready washing machine could be used, which opens when receiving a signal from robot. • Process to open and use washing machine might be learned by robot through repeating a remotely taught process.

Table 15 Food delivery

SERVICE	Food delivery
SHORT DESCRIPTION	User needs food at his apartment at specified time (as offered by "meals on wheels"-services). Thus, robot delivers a prepared meal to users apartment in a predefined cycle. Before leaving, robot can also receive users' choice for the next meal.
HUMAN ACTORS	User, doctor, pharmacist, shop staff
TECHNOLOGICAL ACTORS	AmI, Outdoor robot, Condominium robot, Domestic Robot, indoor sensor network, outdoor sensor network
STAKEHOLDER	Meals-on-wheels-provider or restaurant or care / assisted living facility with own food production
INTERACTION BETWEEN ACTORS	• Robot brings food to users home to a predefined time. Point of receiving food depends on cooperation with other services. • Outdoor robot moves to the restaurant or to a predefined place on the street to receive food. If necessary: Outdoor robot receives food for several users. Alternatively the goods could be received by the condominium robot directly at the door of users' house or apartment, in case a delivery service exists. • Staff of restaurant or delivery service puts food package in basket of outdoor robot. Alternatively: Staff in care or assisted living facility puts food and dishes in roll-fronted cupboard.

	• Robot arranges payment (details to be decided later, e.g. mobile payment as used with smart phones or bank transfer possible) • Robot moves back to user (or to several users), transporting the food. Alternatively robot pushes the roll-fronted cupboard to users apartments. • Outdoor robot hands food package to condominium robot. • Condominium robot brings food package to apartment of user. Alternatively it hands goods to indoor robot. • Indoor robot brings food package to user or to defined place in apartment. Alternatively it might recognize where the user is and bring it directly to him. • If necessary: Indoor robot opens food package or helps user to open it.
OTHER DETAILS	• Service saves a lot of time for service personnel and might be interesting for care or assisted living facilities • Service competes with meals on wheels services, but might also be combined with them (e.g. receiving the food from meals-on-wheels-service on the street and bring it to users' apartment) • Service to select food for next day could help to make food preparation more efficient, since it prevents from overproduction • For the food delivery an agreement with storekeepers / pharmacists should be created to activate the service and to pay goods • Mode of payment has to be chosen (e.g. mobile payment as used with smart phones or bank transfer possible)

Table 16 Cleaning

SERVICE	Cleaning (windows, WC, kitchen, dusting)
SHORT DESCRIPTION	The user has taken an operation to the knee and has regained a medium level of physical functionality. The user feels unsure in doing the same things as before, and starts to be often at home, developing depressive symptoms, that led to decreased attention to personal and home care.
HUMAN ACTORS	User and carers
TECHNOLOGICAL ACTORS	Indoor robot + AmI
STAKEHOLDER	
INTERACTION BETWEEN ACTORS	• The user or his/her carers need support for cleaning the user's home. • The user is not able to do it by him/herself due to physical or psychological problems and the carers have no time free from work for doing that. • The user or the carer can advise the Indoor robot that it is time to clean the home: the user can choose the environment to clean and the activity to perform such as dusting over the furniture. • The Indoor robot can be controlled via tele-operation when performing a specific cleaning task for the first time. Later, the robot might automatically repeat the learned cleaning activity. • In addition, the user can program the robot for cleaning at the night, if it is noiseless.
OTHER DETAILS	• The robot should interact with other domestic tools, if necessary. • The Indoor robot should have a sophisticated system for the orientation inside the home and the recognition of obstacles in the

	path to be removed (i.e. carpet). • A set of cleaning activities should be defined by the user and the carers at the beginning. • The mechanical arm should be enough extensible to reach the top of the furniture or moving under the bed.

Table 17 Communication with friends, family, caregivers, service providers

SERVICE	Communication (video call) with friends, family, caregivers, service providers
SHORT DESCRIPTION	The user is in the bed or has mobility problem so he/she is looking for a device for being connected rapidly with the family, for daily communication or services providers, in case of need.
HUMAN ACTORS	The user, the family and services
TECHNOLOGICAL ACTORS	Indoor robot, indoor sensor network and AmI
STAKEHOLDER	Services providers
INTERACTION BETWEEN ACTORS	• The users and the family have the need of being in contact but the user is not able in using the PC or the mobile phone, so a more intuitive technology is required. • The user calls the Indoor robot and selects the video-call activities on the main menu. • The call is starting and the carers answer from the mobile phone. • The user feels sick and needs the help of someone: the Indoor robot comes and the users can select the home physician number for a rapid communication on his/her health condition. • The user feels weak and conks out: the Indoor robot thanks to the advice of the sensor networks, can start an automatic phone call to the caregivers and the first aid services. • The caregiver can monitor the user, starting a phone call from the PC: he/she can have a tour inside the home and see what happens if provided of a web-cam.
OTHER DETAILS	• The Indoor robot should be connected with the services for the first aid: it is necessary to have a call centre to be in touch with the professionals. • Privacy issues should be defined. • The Indoor robot should have a sophisticated system for the orientation inside the home and the recognition of obstacles in the path to be removed while moving inside.

Table 18 Reminding (of events or taking drugs)

SERVICE	Reminding (of events or taking drugs)
SHORT DESCRIPTION	The user presents some slight difficulty in remembering things to do and appointments. In particular, the user is afflicted by chronic disease such as hypertension or diabetes, so it is important that the medicine assumption can be monitored. In some cases, users could forget important dates, such as medical visits or just events in the community. The reminder function can compensate this.
HUMAN ACTORS	The user and the carers
TECHNOLOGICAL	Indoor robot, sensors network, AmI

ACTORS	
STAKEHOLDER	
INTERACTION BETWEEN ACTORS	• The user suffers from diabetes and has to take different kind of medicine during the day, but sometimes he/she forgets to do or feels a little confused on the right medicine to take. • The carers cannot control every day if the user has taken the correct medicine. • The carers can program the Indoor robot for bringing the right medicine to the user at the right time. • When it's time, the Indoor robot, thanks to the sensors network advice, can bring the box of the pills and a glass of water, to be put under a tray. • Moving inside the home, thanks to the AmI, the Indoor robot can reach the user and give the tray. • The Indoor robot can just give a vocal reminding if the user is able to take the right medicine by him/herself. • If the user is able to move outside by him/herself, the events or appointments can be recorded inside the Indoor robot, that will remind them to the user. • The user and the caregiver can add events to be reminded also through web interfaces.
OTHER DETAILS	• If the medicine is not assumed correctly (i.e. the user has not taken the medicine or has taken another one), the Indoor robot will send SMS and advise to the caregiver. • The Indoor robot should be able to recognize different boxes of medicines. • Reminders might be also connected to places, not only times. E.g., the user could tell the robot to remind him to take his keys, as soon as he is close to the entrance door of his apartment.

Table 19 Garbage collection

SERVICE	Garbage collection
SHORT DESCRIPTION	It is a very cold and windy day and the user has the flu but the dust bin is full and smell bad. So the user would use the Robot-Era service for the garbage collection.
HUMAN ACTORS	User
TECHNOLOGICAL ACTORS	AmI, Outdoor robot, Condominium robot, Indoor robot, outdoor sensor network, indoor sensor network
STAKEHOLDER	Public service provider of garbage collection; municipality
INTERACTION BETWEEN ACTORS	• User alerts the public service provider that he/she will use the robot-era robots for the garbage collection • User activates Robot-Era robots so the outdoor robot reaches the condominium • Domestic robot takes the dust bin and transfers it to condominium robot, condominium robot gives the dust bin to the outdoor and outdoor robot goes to the garbage collection point to unload it • Alternatively, the user can place a garbage bag on a predefined area on the sidewalk, where it is automatically collected by the outdoor robot. Specific times for the collection of garbage might be defined by the municipality.
OTHER DETAILS	• Agreement with public service provider of garbage collection that prepares a point in which the outdoor robot unloads the bin

	• The opening of the house door can be carried out by user however during the project other solutions could be studied also using the robot

Table 20: Outdoor walking support

SERVICE	Outdoor walking support
SHORT DESCRIPTION	It is spring and user would like to go for a walk enjoying of the nice weather and to meet friends. Because of problems in balance, user uses the outdoor robot to support the walk.
HUMAN ACTORS	user
TECHNOLOGICAL ACTORS	AmI, Outdoor robot, outdoor sensor network
STAKEHOLDER	Municipality
INTERACTION BETWEEN ACTORS	• User asks for the outdoor robot • User walks "arm in arm" with outdoor robot because it has a support for the forearm and hand • User guides the outdoor robot through a joystick • Outdoor robot recognizes both path and obstacle presence and alerts user during the walk about obstacles and optimal path
OTHER DETAILS	• Outdoor robot should be designed with a forearm support that should be also adaptable and personalizable to user high • Outdoor robot uses the information coming from the AmI and outdoor sensor network to support the walk • Walking with outdoor robot allows the caregiver to know always where the user is.

Table 21: Objects transportation and manipulation

SERVICE	Objects transportation and manipulation
SHORT DESCRIPTION	User suffers from arthritis and has problems in grasping firmly and moving objects. To clear the table after the meal user gets help from the domestic robot. or: The user cannot leave his bed. Thus, he can ask the robot to bring food or drinks from the fridge.
HUMAN ACTORS	User
TECHNOLOGICAL ACTORS	AmI, Domestic robot, indoor sensor network
STAKEHOLDER	
INTERACTION BETWEEN ACTORS	**Cleaning table** • Domestic robot follows the user while clears the table and goes in the kitchen • User puts dishes and cutlery on the tray/basket of domestic robot • To put away crockery on high shelf and wall cupboard user asks the robot to grasp the object and move it to this shelf **Bringing food to bed** • User asks indoor robot to bring food from fridge to bed. • Robot drives to fridge, opens it and searches for the desired food. The food is stored in plastic boxes which are tagged with an RFID or EAN code. Thus, the robot can identify the correct box.

	• Robot takes box, closes fridge and brings box to user.
OTHER DETAILS	• Domestic robot should have a tray and/or a basket to contain objects to be transported • Domestic robot grasps objects like glasses and is able to reach shelf

Next steps

Task 2.3 "Robotic service optimization and design" aims to design and refine Robot-Era services in order to structure them for satisfying requirements defined by elderly people and other target groups.
The deliverable 2.2 is the first output of task 2.3, which will continue to study and design the structure of Robot-Era services for the two experimental loops till month 36.

The results of D2.2 are the first guide for addressing the design of Robot-Era platforms and the definition of the scenarios for the experimentations. This work is the result of an in dept study of previous researches in social and gerontology fields, of several activities involving elderly volunteers, caregivers and care providers and of the discussion and analysis carried out by all Robot-Era members.
D2.2 will be taken into account also to address the researches of Task 2.5 on the S/T requirements to be adopted in Robot-Era platforms, of Task 8.1 and Task 8.2 that will prepare the pilot settings and experimental protocol for the test of Robot-Era service, and of Task 9.1, Task 9.2 and Task 9.3 that investigate how transferring Robot-Era services and systems on the market.

In the next months, this study will be continued to refine and design the services to be tested in the first experimental loop and, after this event, they will be discussed and refined again in order to identify the final services (that will be described in D2.6) to be implemented during the second experimental loop.

5 References

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