DELIVERABLE D6.1-final
Testing site preparation and protocol development

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<td>SRS</td>
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<td>Multi-Role Shadow Robotic System for Independent Living</td>
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<table>
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<tr>
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<th>Date</th>
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<tr>
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<td>V1</td>
<td>Lucia Pigini, Lorenzo Blasi</td>
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<td>10/06/11</td>
<td>Introductory section added  First revision of chapters:  • Research questions  • Advanced prototype tests</td>
</tr>
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<td>29/06/11</td>
<td>First complete version:  • Chapter method completed,  • Chapter “first case test completed”</td>
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<td>V5</td>
<td>Lucia Pigini, David Facal; Marcus Mast, Rafa Lopez Tarazon</td>
<td>08/07/11</td>
<td>Added draft chapter 7: FIRST NOTES ABOUT SRS COST EFFECTIVENESS ASSESSMENT &amp; SOCIO-ECONOMIC IMPLICATIONS</td>
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<td>V6</td>
<td>Marcus Mast, Lucia Pigini,</td>
<td>08/07/11</td>
<td>Objective indicators</td>
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<td>V7</td>
<td>Marcus Mast, CU, David Facal, Lucia Pigini</td>
<td>04/08/11</td>
<td>Document integration and revision –submitted to EC</td>
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<td>Final</td>
<td>Lucia Pigini, Marcus Mast, David Facal, Alvaro Garcia</td>
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<td>From testing protocol draft version to final version</td>
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EXECUTIVE SUMMARY

The aim of the evaluation phase with potential users is to investigate and measure effectiveness, usability and acceptability of the advanced prototype to generate feedback for improvement. The research goals are to elicit the participants’ acceptance and intention to adopt the new assistive solution, and determine if an effective system enhancing the feeling of autonomy and security at home has been delivered.

This document begins with a summary of the iterative steps conducted so far, involving the stakeholders into the user centered design approach of SRS project. The main research questions are then defined, based on reconsideration of the results achieved in each of the iterative steps, and considering the high priority identified user requirements. Finally, the literature about validation methods is critically analyzed, to find out suitable indicators to assess the defined research questions. The final outcome of this document is the complete user validation plan.

The document reports the SRS prototype validation plan, composed of ten main incremental and complementary stages aiming to address the targeted research goal; each stage concentrating on specific aspects of the evaluation of the prototype, with a specific set of tests, experimental protocols and validation methods.

The stages are designed to be incremental in several respects: complexity of tested functionalities, number of people involved, and maturity of the system.

The document ends showing some preliminary information about measures of social costs, considering that cost-effectiveness assessments need to be performed once the validation process is ended, and the purchase cost of the robot will be more concretely identifiable (third year). However this topic will be treated in detail in deliverable 6.4, expected in 36 month.

NOTE

A draft version of the present document has already been submitted to the EU commission attention in July/August 2011 following a specific request.

The present final document comes from a revision of the above mentioned draft, made at the light of current state of SRS development and ongoing of user evaluation.
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1 INTRODUCTORY SECTION: PURPOSE OF DOCUMENT AND CONTENTS

The present document reports a detailed user validation plan. The validation phase with the potential users should be designed in a way that allows investigating the effectiveness, usability, and acceptability of the advanced prototype, so as to generate feedback for improvement.

This document shows the iterative and user centered design approach adopted during the entire project, summarizing the main steps done so far and the steps that still need to be addressed during the third year of the project. The document includes a sketch of the validation plan with the users, comprising the test sites locations, main aim of tests, time schedule, and number of users involved in the tests (chapter 2).

The user requirements identified during the whole project through the users’ studies are re-considered, in order to identify the main research questions which should be addressed to evaluate the specific SRS prototype developed. Moreover, other research questions are defined in order to evaluate also the usability and social acceptance of the system (chapter 3).

A critical overview of assessment methods is considered essential to allow selecting or helping the design of appropriate evaluation indicators. These indicators will be useful to address the identified research questions, and therefore properly design the final validation plan (chapter 4).

The last chapter reports a detailed description of the validation plan divided in three subparts. The plan was conceived to start as soon as possible with the user tests even in the case that the prototype is not yet completely integrated. The chapter starts briefly describing the whole set of experimental sessions to be held in the three test sites, then summarily explains the different aims of each set of tests, and the need of designing different experimental protocols and validation methods (Chapter 5).

The test sites settings predisposition, plan for ethical and safety issues, research questions addressed, experimental protocol description, and validation methods adopted are reported completely and in detail in the following three separated sub-sections:

Interface usability tests - second iterations - , to be held in Stuttgart test site (IPA Kitchen) aiming to go one step further towards the realism of the interaction (section 5.1).

Real home environment case test, to be held in Stuttgart, to address first SRS experience outside the lab and the first users impressions (section 5.2)

Manipulation and visualization tests,–to be held in San Sebastian, to address the main behaviour of the robot with real users (section 5.3). The complete questionnaires to be adopted are reported in Appendix 1.

Advanced SRS prototype tests, to be held in Milan, to address the integrated SRS functionalities and the scenarios effectiveness with real users in a home environment (section 5.4). The complete questionnaires to be adopted are reported in Appendix 1.

To guide each participant during the scenario execution in the Milan tests, a detailed screenplay will have to be produced for each scenario. The final script will be produced as soon as the development phase will be considered “ready for the tests”. At the light of the current possible development; scenarios’ screenplays have been exemplified (see Appendix 2).

The last chapter reports preliminary information about the SRS cost effectiveness assessment and Socio Economic implications. However, it should be considered that this kind of analysis should be conducted in conjunction with the dissemination and exploitation tasks, and can really start just once the validation process is concluded and a purchasing price of the robot is concretely estimable (third year) (chapter 6).
Appendix 3, reports an example of usage of the proposed method for assessing the social costs, SRS cost effectiveness assessment, and Socio Economic implications. This topic will be reconsidered and developed in deliverable 6.4, expected in 36 month.

2 ITERATIVE VALIDATION PROCESS WITH REAL USERS IN SRS PROJECT

The SRS project is based on a user centered design (figure 1), involving potential stakeholders from the beginning of the study and at each step of the development of the prototype.

Therefore, from the beginning of the project an iterative approach has been adopted. Before the explanation of the next steps of the SRS evaluation plan, a short summary is provided of what done so far to involve the final users in this user centered and iterative approach to the project.

- The project started involving potential users in the focus group, aiming at finding the general features of stakeholders, their predisposition to new technologies, and their needs (not only physical but also social and related to privacy).

- The first results (see D1.1a and Mast M. 2010), provided to the researchers enough information to design ad-hoc questionnaires and to select appropriate validation methodologies (see for example SOTU questionnaire), in order to achieve quantitative results (see D1.1, D2.1 and Pigini L. 2011) about the users’ needs and expectation from a service robot.

- These results enabled the researcher to define specific user requirements, to translate them into technical requirements (D1.2, D1.3), and to hypothesize the first list of SRS scenarios.

- These first list of SRS scenarios were presented again to the potential users through the method of visual simulation, providing a final validation of SRS concept in term of scenario selection, human robot interaction devices, target population (both local user and remote operators), and robot aspect (D6.1-interim report).

- In the mean while an ethnographic research allowed to find out the social, economic, and environmental context of the already defined target population: the elderly people and the informal caregivers (ethnographic research report and Facal D. 2011). The research also described the new identified stakeholders: the 24 hour service operators (D2.2), and with them, the need for another more specific interaction device.

- The achieved results enabled to conduct first usability tests based on a mockup of user interfaces, which generated feedback to improve the next step of interfaces development (D2.2).

- In the mean while, requirements referring to users were taken in consideration and selected according to their importance, as shown in (Table 20 - Full prioritized requirements list- D1.1a)
The results achieved so far allowed the partners involved in the technical tasks to proceed with the development of advanced technology.

This will lead, before the validation phase with real users in a real home environment, to the validation phase of the technical and functional requirements, which will be performed in a controlled laboratory. This is considered of primary importance in order to avoid the likely failure of the tests with users.

The technical validation phase is part of the integration meetings (Wp4-5). The outcome will help to refine the design of the final scenarios. In particular the technical evaluation for the perception components is expected to answer to these questions:

- Possible locations where the objects can be placed
- Which objects can be detected, which not
- Robustness of detection, special focus on object selection by user
- Identification of exceptional cases: obstacles, occlusions, cluttered scenes
- Evaluation of the mapping pipeline for environment modelling

Of course, also manipulation, navigation, user interfaces, decision making and learning has to be evaluated and also the integration of all the components to a fully functional system. In the meanwhile, the user validation tests will start, with the research goal of determining the participants’ acceptance and intention to adopt the new assistive solution, and to determine if the developed solution would:

- For elderly people: enhance the feeling of autonomy and security at home, without making them feel a sort of control over their own life.
- For family members or other private caregivers: provide a less time- and effort-demanding solution to elderly care.

This macroscopic target will be addressed into a validation process which is composed of nine main incremental and complementary stages; each one concentrating on specific aspects of the user’s evaluation of the prototype, with a specific set of tests, experimental protocols and validation methods.
Table 1 shows the complete time schedule of the iterative user’s evaluation plan, including the main steps completed so far in year one (light blue), and in year two (middle blue) and the foreseen steps for the user validation plan (dark blue). Table 1 includes a short description of test sites, the main aim of tests, and the number of users involved in the tests. The table also shows for each WP the number of the task in which the main part of the validation phase will be developed, and the number of the deliverable in which the results of each part of the evaluation plan is (or in most of the cases will be) described. In particular, a detailed user validation plan is provided in chapter 5 of the present document for steps no. (3), (4), (5), (6), (7) (8) and (9). Plan for final validation (step 10) will be designed as soon results of step 9 will be achieved and last technical implementation will be considered concluded (year three).

Because the SRS entire-system evaluation usability tests (task 2.6 - WP2) will be conducted in conjunction with acceptability and effectiveness tests (task 6.3 - WP6), the final results will be reported into two deliverables: D2.2b specifically dedicated to usability results, and D6.2b dedicated to overall results and conclusions about the user validation results (month 36).

**TABLE 1 - USERS’ VALIDATION PLAN AND SCHEDULE (UI-PRO=PROFESSIONAL INTERFACE, UI-PRI=PRIVATE INTERFACE, UI-LOC=LOCAL USER INTERFACE)**

<table>
<thead>
<tr>
<th>No., Time, Duration</th>
<th>Evaluation Description</th>
<th>Participants (provided)</th>
<th>Site, Leader</th>
<th>Task, Report, Report Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) 2011-01 1 week</td>
<td>Initial usability test of user interfaces UI_LOC and UI_PRI using clickdummies and video-simulated robot behavior</td>
<td>7 elders 5 informal caregivers</td>
<td>Usability Lab HDM, Stuttgart Lead: HDM</td>
<td>Task 2.6 D2.2a 31/07/2011</td>
</tr>
<tr>
<td>(2) 2011-01 3 weeks</td>
<td>User evaluation of SRS concept (questionnaire-based survey)</td>
<td>30 elders 23 informal caregivers</td>
<td>3 sites: Italy, Spain, Germany Lead: FDGCO</td>
<td>Task 6.1 D6.1a 31/01/2011</td>
</tr>
<tr>
<td>(3) 2011-12 2 weeks</td>
<td>Usability test of initial version of real user interfaces (no longer clickdummies) of UI_PRI and UI_LOC (basic functions present, connected to Care-o-Bot simulation; non-implemented functions will be simulated) &amp; usability test of first version of UI_PRO (clickdummy). Focus on real interactive behavior, i.e. users will act simultaneously.</td>
<td>10 elders 10 informal caregivers 5 tele-assistance staff</td>
<td>Usability Lab HDM, Stuttgart Lead: HDM</td>
<td>Task 2.6 D2.2b 31/01/2013</td>
</tr>
<tr>
<td>(4) 2011-12 2 days</td>
<td>Usability test of initial version of real user interfaces of UI_PRI and UI_LOC. This is a fork of test 3a, with the same goals but using the real robot (not the simulation). The test has a shorter duration and less participants due to restrictions in the availability of the Care-o-Bot.</td>
<td>2 elders 2 informal caregivers</td>
<td>IPA kitchen environment, Stuttgart Lead: HDM</td>
<td>Task 2.6 D2.2b 31/01/2013</td>
</tr>
<tr>
<td>(5) 2012-01 4 weeks</td>
<td>Local manipulation test</td>
<td>10 elders</td>
<td>IZA Care Center, San Sebastián, Spain Lead: ING</td>
<td>Task 6.3 D6.2 31/01/2013</td>
</tr>
<tr>
<td>(6) 2012-01 4 weeks</td>
<td>Remote manipulation and visualization test with UI_PRO</td>
<td>10 tele-assistance staff</td>
<td>IZA Care Center, San Sebastián, Spain</td>
<td>Task 6.3 D6.2</td>
</tr>
</tbody>
</table>
### 3 RESEARCH QUESTIONS

As already mentioned in the conclusions of D1.1, there are two main aspects that must be taken into account when working in a user-centered design framework: usability and acceptability.

Usability is the perception of the ease of using and learning to use the new devices developed to control the robot. Usability tests have the aim to detect problems related to the use of the systems, in order to improve the subsequent development stages until the feedback from the users becomes satisfactory. For this reason, usability tests of the human-robot interface devices have been carried out from the early stage of the project, with the first iteration in month 12. A second iteration will be carried out when the devices development has reached an intermediate level (month 23), and a third iteration will be carried out towards the end of the project. The third iteration will focus on the usability of the entire robotic system rather than on singular interaction devices.

Social Acceptance instead is defined (Dillon, 2001) as “the demonstrable willingness within a user group to employ technology”. Therefore, the task of assessing the social acceptance in this project could be considered as the evaluation of “the satisfaction and the intention to adopt the proposed robotic solution to solve the identified user needs fulfilling the user requirements”.

Overall, the aim of the evaluations is to generate feedback for improvement in terms of effectiveness, fulfilling of user’s expectations, usability and acceptability of the advanced prototype.

In order to address these main validation goals, appropriate research questions for evaluating the SRS system have to be identified. Considering first of all the evaluation of the fulfillment of the user needs and requirements, table 2 shows the research questions identified to evaluate the effectiveness, usability and acceptance of the system. These questions focus on the user requirements ultimately considered of high importance, as extracted from table 20 - Full prioritized requirements list - of D1.1a.
TABLE 2 - HIGH IMPORTANCE USER REQUIREMENTS AND CORRESPONDING RESEARCH QUESTIONS

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Research question for system evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>The system should be understood to be usable and acceptable</td>
</tr>
<tr>
<td>R08-R09</td>
<td>The users’ objects selections is translated into the correct system actions sequence (the system recognized and identifies the selected objects (shapes, colors, letters on food boxes, numbers on microwave display) and is able to firmly grasp objects without damage them (i.e. bottle, books).</td>
</tr>
<tr>
<td>R34</td>
<td>Communication of action outcomes during performance of the robot, in order to maximize the awareness of the elderly user.</td>
</tr>
<tr>
<td>R35</td>
<td>No robot movement should happen without initial confirmation by the user who is in direct physical contact with the robot.</td>
</tr>
<tr>
<td>R36</td>
<td>There should be a clear indication on the robot side if the robot is in autonomous mode or in remote controlled operation</td>
</tr>
<tr>
<td>R07A</td>
<td>The system should help elderly people with mobility issues such as reaching objects.</td>
</tr>
<tr>
<td>R02</td>
<td>A flexible system of communication and advice sending should be designed, because family caregivers like the system but they do not want to be on-line 24 hours-a-day (related to psychological burden).</td>
</tr>
<tr>
<td>R14</td>
<td>The system should help with coping with unexpected, emergency situations such as falling.</td>
</tr>
<tr>
<td>R22</td>
<td>The system allows communication between user and remote operator, so providing the user with help in housekeeping and mobility could be an indirect way of making him/her able to use more spare time for social contacts.</td>
</tr>
<tr>
<td>R23</td>
<td>Only authorized persons have access to the remote control of the system</td>
</tr>
<tr>
<td>R24</td>
<td>Authentication procedure as a protection of the access to be included for both family caregivers and professionals.</td>
</tr>
<tr>
<td>R26</td>
<td>Avoid possibility of access to the system without explicit consent of the elderly, including non authorized access of authorized remote operators</td>
</tr>
<tr>
<td>R27</td>
<td>If remote operator changes within one session, the elderly user must be informed</td>
</tr>
<tr>
<td>R28-R29-30-31</td>
<td>Personal information data protection managed in a safe way</td>
</tr>
<tr>
<td>R32</td>
<td>An —on/off‖ mode to be implemented in order to protect privacy in very personal moments. The access to the —on/off‖ mode could be adaptable attending to the specific frailty of the elderly user.</td>
</tr>
<tr>
<td>R33</td>
<td>Verication of the plans of action by asking the elderly user before it starts acting.</td>
</tr>
<tr>
<td>R03</td>
<td>The system is able to maneuver in narrow spaces: usually elderly lives in small apartments full of furniture.</td>
</tr>
</tbody>
</table>

Other research questions however have also to be investigated in order to assess the global usability and acceptability of every new product under development, including:

- Advantages/disadvantages perceived
- Attractiveness
- Comfort perception
- Eligibility (Intention to adopt)
- Usefulness

Finally, from a technical point of view, the effectiveness of the SRS scenarios execution will be addressed in terms of:

- evaluating the success of each single task execution
- evaluating the time needed to complete the tasks
- describing the eventual problems occurred in tasks completions
The complete list of research questions, which need to be investigated to assess the macroscopic research goals, is reported in Table 3. To find measurable and standard indicators in order to address all the research questions related to the evaluation of the prototype, suitable validation methods have been selected and developed for the purpose. The next chapter discusses the methods which could be adopted to better answer these goals.

TABLE 3 COMPLETE LIST OF RESEARCH QUESTIONS, ADDRESSING THE MAIN RESEARCH GOALS

<table>
<thead>
<tr>
<th>Main research goals</th>
<th>Complete list of research questions</th>
<th>Validation methods to address research questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>evaluating success of each single task execution</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Evaluating time needed to complete the tasks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>describing eventual problems occurred in tasks completions</td>
<td></td>
</tr>
<tr>
<td>SRS peculiar requirements</td>
<td>Efficiency in ADL task completion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secure in task completion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improving the autonomy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improving of communication and interaction modality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improving safety</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Easy Integration in the private home</td>
<td></td>
</tr>
<tr>
<td>Usability/learnability</td>
<td>Easy to Learn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comfort perception</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Attractiveness</td>
<td></td>
</tr>
<tr>
<td>Acceptability/intention to adopt</td>
<td>advantages/disadvantages perceived</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acceptable from Psychological/emotional point of view</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safeguarding of Privacy and Ethics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Usefulness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eligibility (Intention to adopt)</td>
<td></td>
</tr>
</tbody>
</table>

4 VALIDATION METHODS

In this section, a critical overview of assessment methods is provided, allowing selecting and properly designing the final validation plan detailed in chapter 5.

The main focus of the validation process with the users is to generate a set of recommendations for improvement, in order to obtain user’s feedback including views, feelings, critical suggestions, etc. In this sense, the best approach to get this kind of feedback should be the qualitative investigation of the user’s perception once the SRS system’s potential is tested. Suitable qualitative methods to achieve these kind of results are represented by methods such as “think aloud” (Lewis C. H., 1982), “behavior observation” (Altmann J., 1974), and open questions administered for example through focus group methodology (Krueger & Casey, 2000).

However, quantitative methods are helpful to quantify the overall feedback on usability, acceptability, satisfaction, intention to use, and on more specific features of the developed system. In this sense, suitable measurable standard parameters are needed. This kind of results can bring to a final evaluation enabling also to analytically compare results between groups of stakeholders, or to compare results achieved in following evaluation stages. Table 4 reports a short analysis of quantitative methods.

TABLE 4 QUANTITATIVE AND QUALITATIVE METHODS ANALYSIS

<table>
<thead>
<tr>
<th>Method</th>
<th>What measures</th>
<th>Critical considerations</th>
<th>Fitting with the research questions</th>
</tr>
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<tbody>
<tr>
<td>AttrakDiff</td>
<td>A method to measure</td>
<td>Yes,</td>
<td>Acceptable from</td>
</tr>
<tr>
<td>Reference</td>
<td>Description</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>(Hassenzahl, M., 2003)</td>
<td>attractiveness, hedonic, and pragmatic quality of interactive systems</td>
<td>The AttrakDiff™ provided valuable input regarding emotional perceptions of the users in firsts usability SRS tests and in other projects such as the HERMES project (Cognitive Care and Guidance for Active Aging: <a href="http://www.fp7-hermes.eu/">http://www.fp7-hermes.eu/</a>). Information provided by the AttrakDiff was coincident with qualitative data. Questions adaptable for every kind of product under development. Potential users can easily indicate their perception of the system.</td>
<td></td>
</tr>
<tr>
<td>NARS (Bartneck, 2005)</td>
<td>Negative Attitude toward Robot Scale is a method which allows obtaining a psychological index about attitude toward Robots.</td>
<td>No, attitude toward robot already investigated at the beginning of the project</td>
<td></td>
</tr>
<tr>
<td>PANAS (Watson et al, 1998)</td>
<td>The Positive and Negative Effect Schedule: a self report schedule to measure the positive and negative effects.</td>
<td>No, In order to assess effects related to the interaction with the robotics system, the AttrakDiff matches better the research aims outlined in the previous chapter</td>
<td></td>
</tr>
<tr>
<td>UX Questionnaire (Laugwitz et al, 2008).</td>
<td>The user-experience questionnaire enables to measure user experience evaluation factors: embodiment, emotion, human-centred perception, feeling of security, and co-experience.</td>
<td>Partially, it can help to develop ad-hoc questions</td>
<td></td>
</tr>
<tr>
<td>SCAI (Andrich R., 2007)</td>
<td>instrument: Siva Cost Assessment Instrument: Analysing the cost of assistive technology programmes</td>
<td>Yes, It helps operators and users to estimate the cost of choosing a solution for autonomy (aid, personal care, environmental adaptations, etc.) and to compare the various possible solutions in terms of economic cost. It needs to be adapted to this project in order to be applied in a prospective way with a technology prototype</td>
<td></td>
</tr>
<tr>
<td>PIADS: The Psychosocial Impact of Assistive Devices Scale (Demers L, 2002)</td>
<td>It measures the quality of life (QoL) impact related to the use of assistive technologies from the disabled’s point of view.</td>
<td>Partially, it can help to develop ad-hoc questions</td>
<td></td>
</tr>
<tr>
<td>UTAUT model (Venkatesh et al, 2003)</td>
<td>Model developed to evaluate technology acceptance in term of performance expectancy, effort expectancy, attitude towards using technology, self efficacy, forms of grouping, attachment, and reciprocity.</td>
<td>Partially, it can help to develop ad-hoc questions</td>
<td></td>
</tr>
<tr>
<td>Psychological/emotional point of view (R22)</td>
<td>• Easy to learn (R1) • Improving of communication (R02) • Outcome expectations • Advantages/disadvantages perceived • Attractiveness • Comfort perception • Eligibility (Intention to adopt)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological/emotional point of view of R22</td>
<td>• Psychological/emotional point of view of R22</td>
<td></td>
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<tr>
<td>Psychological/emotional point of view</td>
<td>• Psychological/emotional point of view of R22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving safety R14</td>
<td>• Acceptable from Psychological/emotional point of view R22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secure in task completion (R34, R35, R36)</td>
<td>• Attractiveness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methods for the system economic assessment (as input to the economic study of task 6.4).</td>
<td>• Acceptable from Psychological/emotional point of view</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methodology/Questionnaire</td>
<td>Description</td>
<td>Purpose</td>
<td>Success Criteria</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------</td>
<td>---------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Robot-centric measures (Steinfeld et al, 2006)</td>
<td>Methods focusing on system performance; e.g. does everything work as it should?</td>
<td>No, They do not focus on whether or not the interaction with humans is appropriate, easy, enjoyable, etc. They should be adopted to evaluate the success of single technological innovations, where they would be suitable for usability and technical evaluations of the devices under development (Wp2-Wp4)</td>
<td></td>
</tr>
</tbody>
</table>
| The SUS (Brook, 1996). | System Usability Scale is a standardized questionnaire addressing the effectiveness, efficiency, and satisfaction with a system | Yes, It consists of 10 items and yields a single number representing a composite measure of the overall usability of the system being studied. Questions like “e.g. I think that I would like to use this system frequently” or “I found the system unnecessarily Complex”…can be answered on a 5 scale ranging from “strongly disagree” to “strongly agree” Very generic, adaptable to each new technical system, it does not investigate all the aspect but is very short and easy to complete. | • efficiency  
• satisfaction with a system  |
| Aml Appliances Questionnaire (Allouch, 2009) | Questionnaire designed to examine Ambient intelligence appliances for domestic settings perception | Partially, it can help to develop ad-hoc questions  
Based on other acceptance theories and models of technology such as the technology acceptance model (TAM) and unified model of acceptance and use of technology (UTAUT). 
No need of having experience with the product, a questionnaire dedicated to ambient intelligent systems, such as intelligent fridges and mirrors, but easily adaptable to every technology for the home. | • Attitudes  
• Intentions  
• Investigate adoption  
• Outcome expectations |
| Perceived control in ubiquitous computing (Spiekerman, 2005) | Ease-of-use of the PET, Information Control and Helplessness scales | Partially, it can help to develop had hoc questions about perceived control. 
This construct complement perceptions about improvements in independency – autonomy, which are not always transparent for frail elderly people. 
Perceived control in a UC environment is the belief of a person in the electronic environment acting only in such ways as explicitly allowed for by the individual. User-friendly technology design are actually targeted to increase the perceived control of the users, improving perceived control over information use and maintenance 
Example of statements : “l perceive perfect control over the activity of the system”; “I perceive the system can help me to control over the things that happen to me / the difficulties I have” | • Perceived control in daily life  
• Perceived control in using technologies |
| Scenario-based questionnaires (Gonzalez et al., 2011) | Acceptance of a scenario – task trough specific questions related to the actions performed | Yes, Scenario-based assessments have been successfully applied in ICT projects for elderly people, alone (I Ward) or combined with other methodologies (HERMES, Companionable, Soprano). Target-oriented questions better fit with scenarios/tasks to be assessed when compared to standardized questionnaires. | • Flexibility  
• Adaptability  
• Within context  
• Within the aim of the project |
| RACER methodology (Wiedmann, T., 2009) | Method developed for evaluation of methodologies and indicators | Yes, to verify that the general approach of the evaluation take into account RACER CRITERIA | Referring to the project:  
• Relevant  
• Accepted  
• Credible  
• Easy  
• Robust |
| Ad hoc developed questionnaires - Chih-Hung King 2011 | Ad hoc developed quantitative questionnaires Likert type scale | Yes, they tested a similar robotic platform and developed simple but specific questions related to the particular robotic solution. In the same way, we would need to develop specific questions related to the particular SRS developed platform | • Usability  
• Effectiveness  
• Acceptance  
• Satisfaction  
• Appearance…  
• Safety |
Finally, performance evaluation should also be measured through objective indicators regarding task execution, error rates, and time required to complete the tasks. As an example of this kind of measures the systematic procedure developed by Parson, White, Warner, & Hill (2006) can be taken. The aim of this procedure is to obtain numerical estimates of the effectiveness of task analysis for a wheelchair mounted manipulator for use by severely disabled persons, measuring indexes of the use of various input devices, such as the style of interaction selected, the nature and number of user tasks addressed, task completion times, and the number of available or selected control modes.

In order to take care of the specific research questions linked to the main goal concerning the “SRS peculiar requirements”, a set of ad-hoc questions need to be developed for the purpose. This is because the SRS system is an innovative product, and there are no existing evaluation methodologies appropriate to address some of its features.

Ad-hoc questionnaires based on scenario development (Gonzalez et al., 2011; King C. H. K 2011) have been successfully applied in ICT projects for elderly people or people with motor impairments, alone (iWard), or combined with other methodologies (HERMES, Companionable, Soprano). As an example, the validation procedure of the iWard project has been based on specific questions (i.e. “The user personalizes the robotic creature 0 - 1 - 2 - 3 - 4”), evaluation criteria (i.e. “Patients feel comfortable with the robot Yes/No”), and concrete evaluation criteria for each scenario (Guidance, Cleaning, Delivery, Monitoring, and Surveillance), each presented in separate evaluation sheets (Oztemel et al., 2008). The self-organizing swarm of service robots, modular design of robot equipment, and usability and unique user interface were also assessed separately. iWard is a project close to the technology to be developed and to the validation aims to be covered in SRS. Although iWard’s context of application is a hospital environment, which is clearly different to the home environment targeted in the SRS project, the basic approach can be similar, taking advantage of the flexibility, adaptability, and within-context possibilities of the scenario-based questionnaires.

Ad-hoc questionnaires have also been widely used in the scientific literature, (Caulfield, 2010; Cherubini, Oriolo, Macri, Aloise, Babiloni, & Cincotti, 2007; Mataric, Eriksson, Feil-Seifer, & Winstein, 2007; Parson, White, Warner, & Hill, 2006; Tapus, Tapus, & Mataric, 2008). Cherubini et al. (2007) tested a prototype system that provides remote control of home-installed appliances, including AIBO, through single-step, semi-autonomous and autonomous operating modes with different levels of interaction. The performance of the navigation system was shown by experiments (a comparison between the navigation modes and a autonomous battery charging operation) and, complementarily, the system underwent clinical validation conducted in Fondazione Santa Lucia in Rome with eight subjects suffering from Spinal Muscular Atrophy type II, and six subjects suffering from Duchenne Muscular Dystrophy, in order to obtain the assessment through patient feedback.

The appliances used were installed in the experimental apartment and, as a result, all of the patients were able to master the system and control AIBO within 5 sessions. Most of the patients reported in an ad-hoc questionnaire to have experienced ‘the possibility to interact with the environment by myself’ (Cincotti, Mattia, Aloise, Bufalari, Schalk, Oriolo, Cherubini, Marciani, & Babiloni, 2008). Mataric et al. (2007) conducted a study involving an autonomous assistive mobile robot that aids stroke patient rehabilitation, by using exit interviews and ad-hoc questionnaires about their impressions of the robot that the participants filled-out after each session. Sessions took place in rehabilitation research labs at the University of Southern California Health Sciences campus, with stroke patients with sufficiently mobile to perform the activities in the experiments. Every evaluation session comprised six experimental runs; in all experiments the robot asked the participant to perform one of two activities: the first activity was to shelve magazines; the number of magazines shelved was used as the final evaluation; the second activity consisted of any voluntary activity that involved the movement of an affected arm. Authors used questionnaire data to show that the robot was well-received by both patients and physical therapists and has a positive impact on their willingness to perform prescribed rehabilitation exercises. Parson et al. (2006), after a familiarization stage, a feeding task and a pick and place task, conducted an interview stage using a semi-structured questionnaire to allow a more formal recording of user impressions. These authors recognized that, although questionnaires are of limited value for single-user studies, the approach allows them to structure the interview, ensuring that issues addressed by similar studies were included and facilitating future acceptance evaluations.
From the user side, variables such as perceived control have also been taken into account in design and validation procedures. About perceived control, gerontologists have been increasingly interested in this notion because such perception, which is closely linked with the concept of successful aging, is threatened by age-related changes such as declining health and functional losses (Chipperfield & Greenslade, 1999). Perceived control interacted with functional health and functional status for frailty older adults (Infurna, Gerstorf & Zarit, 2011; Levy, Slade & Kasl, 2002; Menec & Chipperfield, 1997) in terms of perceived health, hospitalization, or mortality. Older adults are less likely than the young to believe there are things that can be done to control aging-related declines because of changes in cognitive performance, health, and well-being (Lachman, 2006). Mechanisms linking perceived control and positive outcomes include adaptive behaviors such as strategy use, physical activity and physical aids. Individuals who perceived low levels of control have been found to need more care and to use more health services (Chipperfield & Greenslade, 1999; Menec & Chipperfield, 1997). In technology projects, perceived control has also been related to privacy issues (Spierkermann, 2005).

In short, we have analyzed different evaluation methods:

- Subjective/Qualitative methods, such as “open questions” or thematic discussions- Focus groups
- Objective/ Qualitative methods, such as think-aloud and behavioral observation.
- Subjective/Quantitative methods, including standard pre-existing questionnaires and ad-hoc questionnaires developed for the SRS purpose
- Objective/quantitative methods for SRS technical performance evaluation or for usability evaluation.

All these methods can be combined in order to achieve a comprehensive evaluation of user acceptance, user experience and intentions to use the technology; together with technical evaluation.

- providing measurable feedback, to obtain objective and comparable results moreover answering to technical effectiveness and usability research goals;
- providing qualitative and quantitative feedback through ad-hoc developed questions, to obtain specific results mostly related to those features of the SRS that are impossible to be analyzed using pre-existing methodologies, and also feedback about acceptability, attractiveness, usability, intention to adopt, etc.,
- finally providing also qualitative feedback, respect to all research questions related to the social and psychological impact (that is, almost all except those related to effectiveness), in order to understand in deep the mechanisms affecting the quantitative results.

The following Table 5 shows how the mixed approach evaluation methods would fit with the research goals, answering to table 3 question mark.
TABLE 5: THE PROPOSED MIXED EVALUATION METHODS APPROACH COVERING THE RESEARCH GOALS (IN THE YELLOW RECTANGLES)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Subjective</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Qualitative</strong></td>
<td>Obtained through open questions:</td>
<td>Obtained through Video/Audio recording:</td>
</tr>
<tr>
<td></td>
<td>• Why questions</td>
<td>• Think aloud method</td>
</tr>
<tr>
<td></td>
<td>• Focus groups</td>
<td>• Behaviour observation</td>
</tr>
<tr>
<td><strong>Research goals addressed:</strong></td>
<td>• Acceptability/Intention to Adopt</td>
<td>• Acceptability/Intention to Adopt</td>
</tr>
<tr>
<td></td>
<td>• Usability/Learnability</td>
<td>• Usability/Learnability</td>
</tr>
<tr>
<td></td>
<td>• SRS peculiar requirements</td>
<td></td>
</tr>
<tr>
<td><strong>Quantitative</strong></td>
<td>Obtained through subjective Numeric scale:</td>
<td>Obtained through instrument or other objective Measures:</td>
</tr>
<tr>
<td></td>
<td>• Questions based on Likert-type scale (standard questionnaire or developed ad hoc)</td>
<td>• User Learning time</td>
</tr>
<tr>
<td><strong>Research goals addressed:</strong></td>
<td>• Acceptability/Intention to Adopt</td>
<td>• User Time saving...</td>
</tr>
<tr>
<td></td>
<td>• Usability/learnability</td>
<td>• SRS Technical performance</td>
</tr>
<tr>
<td></td>
<td>• SRS peculiar requirements</td>
<td></td>
</tr>
</tbody>
</table>

5 PROTOTYPE VALIDATION PLAN

The SRS prototype validation plan is composed of several incremental and complementary stages, as indicated in table 1, chapter 3. The stages are complementary because each one will concentrate on specific aspects of the evaluation of the prototype, with a specific set of tests, experimental protocols, and validation methods. The stages are also incremental in several respects: progress of technical development, complexity of tested functionalities, number of people involved, and maturity of the system.

Execution of the evaluation tests involves different test sites; they are located in Germany (Stuttgart), in Spain (San Sebastián), and in Italy (Milan), where the final SRS demonstration will also be shown.

The first set of tests (December 2011), has been performed at the Fraunhofer IPA model kitchen and at the Usability Lab of Stuttgart Media University, regard the second iteration of usability tests of the SRS user interfaces.

The whole system pre tests will be performed at a private home located in Stuttgart (February 2012), and will be used to determine which specific difficulties the SRS prototype could encounter in a real home environment, with respect to the controlled laboratory environment in which it has been tested so far. Some possible tests in this first stage will be for example: check the time needed to learn a new map for a real house, check functionalities under real lighting conditions, verify reception of WiFi antennas, etc. All the identified difficulties will be noted and this list will be the basis for preparing the Milan testing site, which could be considered as another unknown and new home environment. Another focus of these first field tests will be the possible impacts on the apartment and the restrictions created by the presence of the robot, concentrating thus on user requirements related to the integration in a private home and the safeguarding of privacy.
Three set of tests will be performed at IZA Care Centre of San Sebastian (January 2012 –first iteration and April 2012–second iteration). These tests have to determine effectiveness, acceptability and usability of the arm subcomponent. They will involve a greater and more various set of users, both Local Users (LU, the elderly) and Remote Operators (RO). Evaluation in this phase will be related to the functionalities satisfying requirements such as safe manipulation, secure grasping, and learning.

Finally, the more complex set of tests will be performed in the Milan apartment (May 2012), and will finally focus on the effectiveness, usability and acceptability of the whole prototype in an advanced stage of development. Evaluation will be related to the major user requirements, and especially on the improvements in ADL performance through the execution of real-life scenarios experienced by real users.

A complete and detailed description of each set of tests including objectives, preparation work, method, and evaluation procedure, is provided in the following sections.

5.1 INTERFACE USABILITY TESTS - SECOND ITERATION

5.1.1 OBJECTIVES
The second usability test of the SRS user interfaces aims to go one step further towards the realism of the interaction. These tests builds on:

- First version of clickdummies of UI_LOC and UI_PRI
- Usability test results of the first version clickdummies
- Second, improved versions of the two clickdummies having been passed on to development

The test artifacts will be:

- First version of the real (non-clickdummy) interactive user interfaces of UI_LOC and UI_PRI (mobile devices for elderly and informal caregivers)
- First version of gesture-based local interaction
- First version of UI_PRO clickdummy

As in every usability test, the overall objective is to find usability problems and improvement areas in the tested artifacts. Furthermore, specific interaction solutions that are considered candidates for interaction design patterns will be evaluated for their appropriateness and ability to answer the underlying problem.

5.1.2 METHOD
This test focuses on the real interactive behavior, i.e. informal caregivers and elderly users have to interact simultaneously in the same test session with the robot. SRS Functionality not yet available can be simulated (for example with a wizard-of-oz approach). These tests need to be carried out at two test site locations:

Fraunhofer IPA model kitchen, Stuttgart: 2 elders and 2 informal caregivers are provided to interact with the SRS system through gestures, UI_LOC, and UI_PRI.

Usability Lab at Stuttgart Media University: 10 elders, 10 informal caregivers, and 5 tele-assistance staff would participate. The Care-o-Bot simulation have to be used instead of the real robot. In addition to UI_LOC and UI_PRI, the initial clickdummy version of UI_PRO need to be tested with a similar approach to the evaluation of the first iterations of UI_LOC and UI_PRI clickdummies, i.e. using videos and improvised interaction to substitute real interaction.
The method includes task-based interaction, thinking-aloud, structured interviews on the appropriateness of potential interaction patterns, and the AttrakDiff questionnaire to obtain quantitative data on the overall user experience.

WHOLE-SYSTEM PRE-TEST IN REAL HOME

The main goal of this evaluation is to determine the specific technical difficulties that SRS will have in a real elderly home environment as opposed to the lab environment where it has been used so far. This could for example be due to door widths, lighting conditions, carpets on the floor, objects, small corners that cannot be reached, weight of the robot, reception of WiFi antennas, etc. The robot will be used for navigation and manipulation tasks taken from the SRS scenarios. This test can be considered a pre-test for the complete set of SRS evaluation, in this first time with main focus on technical aspects. All difficulties that emerge will be noted. The results of this test will be the basis for preparing the final testing site in Milano. The Milano site will be prepared in such a way that all the difficulties that the robot would encounter in a home which is actively used by elderly will be encountered there too, with the exception of such obstacles that would hinder operation of the robot. Further objectives are to determine the impact and restrictions for elderly users due to the robot (e.g. furniture that needs to be removed or moved), perception of the robot by the users, potential safety hazards, and privacy-related issues.

5.1.3 OBJECTIVES
In particular, the objectives are:

- Inform the preparation of the final SRS evaluation: determine robot’s operational limits in a real home environment (e.g. problems with small room sizes (e.g. for object detection), with floor types, maximum height of an object, maximum weight of an object, required light necessary for visual system, etc.)
- Inform development: determine current progress of SRS system components (generate list of all non-working components and list all issues with working components), determine potential safety issues
- Collect initial data on restrictions for elderly users due to the robot (e.g. furniture that needs to be removed or moved)
- User perception: Determine potential psychological issues when using the robot in a home (e.g. privacy-related issues, ethical issues), determine appropriateness of robot aspects like speed of movement (too slow or acceptable?), approach behavior (e.g. scary when approaching from the front?), adequacy of volume of operation (e.g. should the robot announce itself when entering a room because it is too quiet?), any other surprising or unpleasant behavior

5.1.4 PREPARATIONS

5.1.4.1 APARTMENT SELECTION REQUIREMENTS
Relevant data and limits of the robot have been determined in preparation of the test. Selection and adaptation of the apartment considers these restrictions. However, since the robot has never been tested in a real home, some of the figures are estimates or have been determined experimentally, not by practical application:

- Robot weight (relevant for transport): 180kg; this disqualifies any apartments other than ground floor except if there is an elevator
- Minimum width of a narrow passage (door) to pass: 0.83 m (robot footprint is 0.6m x 0.8m)
- Maximum height of a door sill: 0.5 cm to 1 cm in autonomous mode; 2 cm in manual mode
- Maximum climbable slope: 5° to 10° in autonomous mode; max. 30° in manual mode
- Permissible floors: any flat and hard ground works fine (e.g. parquet, linoleum); with some limitations also (a well-fixed) carpet or (not to uneven) tile floor (navigation will not work properly on uneven floors)
- For turning around its own axis, the robot needs a radius of at least 0.8m
Load on floor: it should be considered that the robot’s 180kg are distributed over four wheels which nearly have only a point contact to the ground

5.1.4.2 Object grasping requirements

For grasping objects, the following limits have been determined beforehand. Again, these are approximations and the precise limits will be determined during the test.

Types of objects suitable for grasping:

- Only solid, not deformable objects
- Nearly box-like or cylinder-like shape
- With current (not anticipated) object detection algorithm, objects would have to be textured (not uniformly colored); if new algorithms are already in place there is no such restriction
- Object size should not exceed approx. 20 cm in the smallest dimension; however door handles can still be dealt with as an exceptional case
- Examples of permissible objects: bottles (0.33-0.5 liters, e.g. Coke), cups and glasses (ideally without handle), books (not too heavy or too large, normal paperback books can be dealt with), grocery packages: boxes, cans (e.g. Pringles)
- Maximum vertical reach: 2m. However, a height between 0.5m and 1.5m is the ideal range to have a reasonable workspace for manipulation
- Maximum workspace for reaching objects in front and back of the robot: in front approximately an area equal to the size of the tray; on the backside the arm can reach objects placed approximately 1m from the centre of the robot, that is, approximately 0.5m from the rear wheels
- Maximum weight of an object: the end effector’s tactile sensors are quite sensitive, therefore the maximum weight of objects with small bearing surfaces is likely to be around 2 kg (e.g. a bag that “cuts” into the gripper due to its small bearing surface); objects with a large bearing surface (e.g. a bottle) might weigh up to 5kg; however these numbers have to be verified

5.1.4.3 Technical and other necessary equipment

The following equipment will be required on the test site:

- Wireless access point with 802.11n (Internet connection not required for robot operation)
- Laptop computer for SRS communication server
- 3G HSPA USB Internet stick for robot setup phase
- Wireless emergency push-button for stopping the robot
- Wireless joystick for manual steering of CoB
- Laptop for control and scripting of CoB
- Ramp for pushing Care-o-Bot up the stairs
- CoB battery charger
- Mobile video recording equipment (cameras, tripod, etc.)
Laptop for session transcript and electronic questionnaire

5.1.5 METHOD

5.1.5.1 RECRUITMENT
The test will be carried out in a real apartment (in active use) of an elderly person (or an elderly couple). Participants will be two elders and two informal caregivers conforming to the SRS target group specification. The elderly person living in the apartment will be asked to refrain from making any changes to the apartment except for removing unique valuables (removed items will be noted).

5.1.5.2 EVALUATION PROCEDURE
There will be two test trials with elderly people. Two interviewers will be attending to the two participants. The duration of each trial will be about 90 minutes. However, there is a high degree of technical uncertainties in this pre-test, thus, participants will be cautioned beforehand about possible technical problems and associated wait times. The two sessions will be recorded on video with several cameras in the apartment as well as with the robot’s cameras.

The general procedure will be that the robot carries out the SRS “fetch and carry” scenario initiated by the elderly person or by the informal caregiver, fetching an object, navigating through several rooms, and delivering the object to the elderly person. This scenario will be supplemented with several central elements from the other SRS scenarios. At the time of the test, not all SRS components will be fully functional. The approach is to improvise (e.g. by using a wizard-of-oz approach, showing a video, or the CoB simulation) any functionality not yet implemented.

The following procedure will be used:

- Greeting participants, sign informed consent
- Introduction to SRS concept including pictures of application scenarios
- Elderly participant sitting on the couch in the living room commands the robot to bring a bottle from the kitchen using his handheld interaction device
- Robot fetches a bottle from the kitchen and brings it to the elderly participant sitting on the couch
- Participant gives a book he just finished reading to the robot and the robot places it in a shelf (alternatively another object that has already be taught to the robot such as Pringles box; to be determined)
- Participant uses his device to tell the robot to go back to its charging station located in another room.
- Robot goes back to charging station.
- Interview on user perception

The following evaluation methods will be used:

- Evaluation list for technical performance of system components
- Interactive think-aloud with moderators next to participants
- Structured interviews using prepared questions on robot perception

5.2 MANIPULATION AND VISUALIZATION TESTS

5.2.1 OBJECTIVES
Manipulation and visualization tests in San Sebastian are planned to address the main peculiarities of the robotic arm with real users (elderly and potential professional remote operators), and to study the effectiveness, usability and user acceptance of its arm/manipulation. The experimental objectives of the tests are:

- Determine the accuracy and efficiency of the robotic arm manipulator in performing tasks (selected from scenarios).
- Evaluate the feedback provided to the professional operators through the visualization system of the UI-PRO device during tasks executions.
- Collect data about users’ subjective perception on the robotic arm and on tasks based on arm manipulation. Because of their peculiar appearance and technological restrictions, current robotic arms like those used within the SRS project could evoke a peculiar response in elderly users. By combining quantitative and qualitative responses to robotic arm movements with feedback-visualization, we expect to gain knowledge on how to improve elderly user-robot interactions based on robotic arm manipulation.
- Collect data about user acceptance and will to use the technology (both elderly and potential professional remote operators).

5.2.2 PREPARATIONS

In these trials, full assistance will be obtained from both the Rehabilitation Service of Birmingham Hospital and Ingema’s laboratories, placed very close to each other (see Figure 3). Depending on the requirements of the technology to be tested, and the mobility difficulties of the frail elderly users, the Rehabilitation facilities for in-site testing may have to be used.

Ingema’s laboratories will be used for technology installation and test making with remote operators, and eventually also with the elderly users.

Regarding ethical issues, a document has been approved by the Matia/Ingema/Urkoa Ethics Committee to complete the documentation already approved about the first survey on users’ needs. This documentation includes experimental protocol description, informed consent, authorisation for video recording documents and, documentation about storage and exchange data procedures with other partners.
5.2.3 METHOD

5.2.3.1 RECRUITMENT
Tests with advanced prototypes are based on an experimental protocol involving 20 participants (recruitment criteria are defined into D6.1-1):

- 10 local users (LU): frail elderly people attending to the Rehabilitation Service of Birmingham Hospital (Matia Foundation). This building is located beside Iza Care Centre, where Ingema’s laboratories are located. Elderly people attending the Rehabilitation Services are mainly involved in therapy for functional recovery and, if possible, autonomy. The profile of patients of the Rehabilitation Service match the definition of frailty included in D1.1R.
- 10 remote operators (RO-PRO): potential professional users of the SRS system.

5.2.3.2 EXPERIMENTAL PROTOCOL
These trials focus on grasping and fetching things, as well as on the visualization systems supporting these actions:

- Regarding the requirements, the main aim of manipulation and visualization tests is to answer to research questions concerning the ease of learning for the user (referring to user requirement R1 – “The system should be usable and acceptable” - and referring to requirement R09 – “The system is able to firmly grasp objects”).
- Regarding the acceptance, the typical dimensions will be observed including: outcome expectations, advantages/disadvantages perceived, attractiveness, comfort perception, eligibility (intention to adopt) and perceived usefulness.
- Regarding the performance evaluation, the success on task execution will be recorded, as well as the time required for its completion, and the errors and/or usability difficulties that may occur within the process.

In order to achieve these results, the final scenarios selected within WP1 have been analyzed, and two situations/use cases where manipulation is the main part of the action have been selected. In this regard, an integrated assessment of a single but interrelated part of the scenarios can be conducted, and also an evaluation within a scenario-based framework.

The situations selected are:

- Month 24 (January/February 2012) - Manipulation test. This test is going to be conducted with frail elderly people. The robotic arm will be locally controlled by an experienced user by using an already existing local application programming interface (that will imitate the UI_PRO controlling the COB), simulating the way in which a professional user would act and trying to simulate the use of the UI_PRO as much as possible.
  
  This test is going to be based on Scenario 1: “The elderly person lies down. He/she wants some milk, but the carton is placed far from him/her on the table, so he/she uses the robotic arm to bring it closer (...).”

- Month 24 and 27 (January and April 2012) - Visualization test. This test is going to be conducted with potential professional operators by using the UI_PRO for robot visualization and grasping. In this test, the robotic arm is not directly needed, so it is going to be simulated on a laptop. The usage of UI_PRO will be investigated in order to determine if it provides the professional users a tool to control the SRS system. One of the main features of UI_PRO is in fact its capability to provide a "visualisation of environment". This visualisation will be perceived not only through the cameras of the COB, but will capture also a visualization of the simulated

environment by means of the remaining sensors. For example, using only a webcam is very difficult to grasp an object, so 3D info is needed in addition to provide the user a better knowledge of the environment.

This test is going to be directly based on Scenario 1: “The LU asks for a glass of water. So the RO wants to fetch a bottle of water and a glass from the kitchen. He uses a room plan to specify that SRS should go to the kitchen. Having arrived in the kitchen, the RO switches to manual navigation mode to drive SRS to the specific place where the bottle and glass are located (...). Then (...), and then the RO directs SRS back to the bedroom of the LU (...”).

This task will also be repeated several times in order to measure the learnability (time required in $T_{n1}$ compared with time required in $T_{n2}$).

Although these trials mainly focus on the manipulation abilities of the system, they give also the chance to test the human-interface devices developed so far, concentrating on the specific context of the manipulation tasks.

Each test session will be supervised by at least two SRS Operators, one from Robotnik taking care of technological aspects, and one from Ingema coordinating the experimental procedure and registering qualitative data. In the manipulation test, in which a frail elderly person is involved as LU, a care professional, possibly already known to the elderly person, will also be involved in the process. This professional operator will assist the LU, monitoring his/her conditions and being available for intervention (i.e. if the LU desire to stop the test).

5.2.3.3 EVALUATION PROCEDURES
The main parameters to be measured in these trials are:

- Secure grasping (Efficiency in ADL task completion)
- Usability + Learnability
- Acceptance (Comfort perception)
- Acceptability (from a Psychological/emotional point of view)
- Safe manipulation (the elderly person is out of the working area of the robotic arm during the test; subjective perception from the elderly person –to be discussed with the consortium–).
- Perceived control in daily life

Complementarily, personal information is going to be collected from the frail elderly adults (frailty, cognition, experience with technology, social support) and the potential professionals (professional background, processing speed, experience with technology). At the end of the scenarios, a specific assessment will be conducted including: specific questions mainly related to the dimensions discussed above (including secure grasping, usability, improvement of communication, intention to use the system if applicable). A resume of the dimensions measured is included in Table 5. The complete assessment protocols are included in Appendix 4 (Manipulation Tests assessment protocol) and Appendix 5 (Visualization Tests assessment protocol).
In elderly people, frailty is measured with the Barber test (Barber, Wallis, & McKeating, 1980), as in previous researches within this project. This classic and quick test has been complemented in Manipulation Tests assessment protocol with the SHARE Frailty Instrument (Romero-Ortuno, Walsh, Lawlor, & Kenny, 2010), simple instrument for frailty screening in Europeans aged ≥50 validated using data from the first wave of the Survey of Health, Ageing and Retirement in Europe (SHARE, http://www.share-project.org, primarily funded by the European Commission through the 5th framework programme project QLK6-CT-2001-00360), a large population-based survey conducted in twelve European countries. The SHARE FI has sufficient construct and predictive validity, it is easy to apply and include self-reported variables such as fatigue, loss of appetite, functional difficulties, and also an objective variable, the grip strength. The SHARE FI is readily and freely accessible via web calculators (for women at http://www.biomedcentral.com/1471-2318/10/57/suppl/S1 and for men at http://www.biomedcentral.com/1471-2318/10/57/suppl/S2). By including both the Barber test and the SHARE FI in these trials we look for compare classical and modern index measuring frailty in a easy and quick way.

In professionals, learnability will be objectively measured, recording the time required to carry out the task in several applications, and the errors. The aim of this part of the assessment is to check whether it is possible to learn how to operate with the robotic arm and its visualization system in an accurate, but also acceptable way. Since learnability refers to the experience of a new user when he/she is starting to use the system (it should be possible to learn quickly and error-free), it can be properly measured, because the characteristics of the tests are based on multiple repetitions of the same task. Complementarily, specific items about learnability adapted from existing scales will be included in the experimental protocol (i.e. “It is easy to forget how to do things” or “It is easy to make the software do exactly what you want”, but also “Working with this software is mentally stimulating”).

Usability questions will be performed based in the Visualization Trials on the UI_PRO development stage. At this point, it will be measured how easy/difficult is the interaction with the interface. In order to control participants’ abilities and its relation to their use of the interface, basic health conditions and processing speed are measured.

All the measures are going to be completed with information collected by Ingema’s staff through different methods: a) participant observation in Test 1 - Manipulation test with elderly users; b) think-aloud recording in Test 2 - Visualization test with potential caregivers. With these methods, qualitative information that complements and confirms the information collected directly from the users will be obtained.
Complete questionnaires are reported in appendix 1.

5.3 ADVANCED SRS PROTOTYPE TESTS

5.3.1 OBJECTIVES
The most comprehensive set of tests will be performed in the Milan apartment, focusing on the evaluation of the whole prototype in an advanced stage of development. The evaluation will consider the major user requirements determined at the beginning of the project, expressed through real-life scenarios which will be experienced by real users. In these last tests, all the previously mentioned research goals will be assessed. The evaluation will run in conjunction with the final usability tests as part of task 2.6. Therefore, the work will be planned by the partners of both WP6 and WP2. The final results will be reported separately in two deliverables; D2.2b specifically dedicated to the usability results, and D6.2 dedicated to the overall results and overall conclusions about user evaluation (month 36).

5.3.2 PREPARATIONS
The acceptance tests of the advanced SRS prototype will be performed into an apartment located inside the hospital Santa Maria Nascente of Don Carlo Gnocchi Foundation. The selected test site, called “SMART HOME” (described in detail in D6.1-1) is part of the DAT service (Ita: Domotica, Ausili e Terapia Ocupazionale – Eng: Occupational Therapy, Assistive Technology, Smart Home), a specialized service of Don Carlo Gnocchi Foundation which provides information, guidance, consultations and individual assessment in the field of assistive equipment for people with disabilities.

A formal collaboration with the DAT service has been agreed. In the context of this collaboration DAT will provide:

- Involvement of health professional staff for the tests execution, in order to provide expert advice and support for the privacy and safety management of the elderly (clinical responsibility);
- Availability of the test site for the evaluation period.

Other contacts are going to be made with tele-assistance centers for elderly, in order to recruit also real 24 hour operators for the experiments. If no tele-assistance operator can be recruited, the plan is to involve DAT health professionals for this role, as their attitude and knowhow can be comparable to the one required for tele-assistance operators specialized on elderly support.

Documentation about ethical and safety issues has been approved by the Ethics Committee of Don Carlo Gnocchi Foundation, to complete the documentation already approved about the first survey on user needs. The documentation includes: experimental protocol description, informed consent, authorization for video recording, the documentation about sensitive data storage and exchange procedures.

The apartment used for the evaluation tests will be prepared and “configured” taking into consideration the results of the ethnographic research and the final scenarios. The house rooms mentioned in the planned scenarios are: kitchen, bedroom, living room, way to toilet, entrance. The office and the tele-operator centre places will be hosted in other room of the apartment, indicated in figure 2 as “Remote operators room”.

Other technical and logistic problems are now under examination, for the moment the following features where checked:

- internet access and wifi access point available inside the house
- door passages accessible to the SRS platform (minimum door passage=82 cm)
- Easy access to the house allowing the first arrival of the robot
- Locked room to keep the robot secure when not in use.
The setup of the apartment will be optimized to minimize reconfiguration between subsequent tests. Moreover, as soon as the Stuttgart tests in a real home will be performed, the results will be taken into account to finalize the apartment predisposition.

5.3.3 Method

5.3.3.1 Recruitment

Tests with the advanced prototype will be based on a protocol involving the potential users of the system (recruitment criteria are defined in D6.1-1):

- 10 local users (LU): the frail elderly people
- 10 private remote operators (RO-PRI): relatives of the elderly people
- 3 professional remote operators (RO-PRO): potential tele-assistance operators of a 24 hour call centre service for elderly
5.3.3.2 EXPERIMENTAL PROTOCOL

The evaluation tests will be based on the three scenarios which have already been selected and validated by users in the course of the project:

- Situation monitoring and Basic fetch and carry
- Emergency assistance chain
- Fetch and carry of “difficult” objects

Participants will perform the defined scenarios using the three human interface devices developed by the project:

- UI-LOC, the device dedicated to local users (elderly),
- UI-PRI, the device dedicated to relatives or private caregivers or also to those elderly particularly skilled with technology,
- UI-PRO, the device dedicated to 24 hour professional remote operators.

Using these devices both elderly and remote operators will cooperate in playing the selected demonstration scenarios. Through the scenarios each participant will have the possibility to control the robot, see it in action, and appreciate a concrete result in order to give a feedback. Table 7 summarize scenarios actors and use of devices. Details are reported into annex 2.

**TABLE 7 SCENARIOS: PARTICIPANTS AND DEVICES**

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Request start from:</th>
<th>Robot control by:</th>
<th>Devices:</th>
</tr>
</thead>
</table>
| 1 Situation monitoring and basic fetch and bring | • RO-PRI starts the call to check situation,  
• LU expresses a need,  
• RO-PRI controls SRS to solve the need | RO-PRI                | UI-LOC  
UI-PRI |
| 2 Emergency assistance chain                 | • LU starts the emergency call  
• RO-PRO answers cause RO-PRI is not available, RO-PRI join s soon as he/she is free | RO-PRO first  
RO-PRI-join | UI-LOC  
UI-PRO  
UI-PRI |
| 3 Fetch and carry of “difficult object”      | • LU starts to control the robot by him/herself but then asks for support of RO-PRO | LU                    | UI-LOC  
UI-PRO |

As indicated in the D1.3a (2.4.1 Phases of SRS System Usage) the lifecycle of an SRS system is composed of three main phases: Pre-Deployment (or Production), Deployment and Post-Deployment (or Operational). At the time of this evaluation test the Pre-Deployment phase will be considered finished, with the robot knowledge base already loaded with action sequences, household objects and 3D models. As soon as the robot will arrive at the Milan site the standard Deployment phase will be executed, in order to perform personalized setup actions such as loading a 2D map of the apartment, building a 3D map of the environment, recognizing and learning the position of useful objects, etc. The focus of the evaluation tests will be on the Post-Deployment / Operational phase, i.e. on the everyday use of the system where new objects and action sequences are still learned.

Figure 4 shows the current provided calendar for the tests activities
May 2012 Calendar

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 (April)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

SRS arrival, Technical arrangement, learning phase

| 6 | 7 | 8 | 9 | 10 | 11 | 12 |

User tests

FIGURE 4: PROVIDED CALENDAR FOR MILAN TEST ACTIVITIES

To guide each participant during the test execution, a detailed screenplay has been produced for each scenario. A draft version of it is available in the Appendix 1. Details of each scenario are already available in the internal “SRS scenario revision process” living document. This document is continuously updated during the course of the project based on real technical development. The final screenplay will be produced as soon as the prototype is in a sufficiently advanced development stage so that the scenarios can be defined as “final”.

To create a detailed plan and assign the test participants to the scenarios, at least three things are to be considered: how many people will participate to each scenario, how much time the average elderly person will stand up while playing the scenarios and performing all the related activities, and how much time will be needed to run each scenario.

At the moment it can be estimated that each experimental session will involve up to three participants: an elderly (LU), and one or two ROs (just the relative RO for scenarios 1-3 and both the relative and the 24 hour operator for scenarios 2-4).

The duration of each test should not be a problem for ROs, but must be carefully considered for the involvement of elderly people, who should not get tired too much as a result of this activity. Based on previous experiences, and mediating between the need to conduct quite long and complex tests and the need to involve frail participants, it is currently estimated that each experimental session should not last more than two hour and a half. This time will be considered as an upper limit not to be exceeded and thus a constraint for scheduling the testing sessions.

A first estimation of the time has been run through a “wizard of oz” first experimental session made by real potential users and actors,

In particular participants (figure 5) were an old frail woman (85 years old), her daughter (60 years old) and two actors performing respectively the remote operator and the robot. An SRS operator was suggesting the scenario play to all participants. Four scenarios were performed and before of that the general procedure was explained and an informed consent for video dissemination was signed. Video can be found into the SRS project website [http://srs-project.eu/node/264](http://srs-project.eu/node/264) (“srs scenario simulation miovies” section)
The time needed to perform this session resulted of two hours. Apart from producing a first estimation time needed, the aims of these wizard of oz trials were about:

- Evaluating the comprehensibility of the language to the participants
- Evaluating first impressions and usability of proposed indicators
- Evaluating how to manage a multi participant trial
- Providing learning material to teach all the DAT health professionals operators involved in managing the experiment.

These first real users trial estimation, together with technical results actually achieved enabled to design the test session. Each test session will be supervised by a DAT health professional and a number of SRS Operators (SRS OP):

- A DAT health professional, possibly already known to the elderly person, will assist the LU, monitor his/her conditions and will always be available for intervention or should the LU desire to stop the test
- An SRS OPERATOR will assist the RO-PRI, both for the use of the human interface device and to coordinate the test
- An SRS OPERATOR will assist the RO-PRO, if any is involved in the test, both for the use of the human interface device and to coordinate the test
- An SRS OPERATOR will be responsible for data collection, in particular video recording and technical assessment
- An SRS OPERATOR will coordinate the test and will be responsible for marking timestamps at each test step

Each test session ideally will be composed of the following steps:

1. The coordinator marks the session starting time and declares the current test session open
2. A DAT health professional will explain to the LU the general aim of the study and the particular aim of the current test. The SRS OPERATORS in the mean time will also explain the same to the ROs
3. The LU and the ROs will read and sign the informed consent and the authorization for video recording documents
4. A DAT health professional will explain to the LU how to run the test and how to use the interaction device, collecting information about usability aspects. The SRS OPERATORS in the mean time will do the same with the ROs
5. The SRS OP acting as coordinator, after verifying that every participant is ready and that all the subsystems work properly, will order the startup of a scenario and mark the scenario starting time.

6. The LU and the other ROs participant(s), assisted by their respective operators, will play one of the three scenarios (see annex 2), while

7. The coordinator supervises the smooth running of the test, marks a timestamp for each step and, if needed, suggests to any participant who is experiencing difficulties how to proceed.

8. At the end of the test the coordinator marks the ending time, and instructs each operator to start the data collection and rearranging phases.

9. Each assistant will ask to their respective participant some evaluation questions and will record the answers, while

10. The coordinator eventually re-arranges the set up before the execution of the following scenario and

11. The data collection operator archives the recorded videos and prepares for a new recording session.

12. When the data collection/rearranging phase is terminated, the coordinator verifies that enough time is available for testing another scenario and orders to prepare for the startup of a new scenario.

13. The session continues at step 4.

14. If no more time is available or if all of the four scenarios have been tested, the coordinator instructs each operator to start the final data collection phase.

15. Each assistant will ask to their respective participant to fill in the final questionnaire.

16. At the end the coordinator declares the testing session closed and marks the ending time.

In the following figure 6 a possible position in the apartment is indicated for each participant during a testing session.
5.3.3.3 EVALUATION PROCEDURE
Each experimental session will be video recorded, using the 5 cameras (AXIS 212 PTZ) integrated into the walls of the kitchen corner and the remaining of the open space room, see Figure 5. Another camera will be located also in the bedroom (Figure 7).
During the execution of the scenarios, the participants will be asked to “think aloud” so as two SRS operators, watching the tests from the technical room outside the test site, could take note of every particular behavior, reaction, comment, first impression while video and audio recording.

In the mean time, the SRS technical operators will also have to record objective and measurable parameters about the technical effectiveness of each scenario. Suitable effectiveness indicators will be provided by technical partners as soon as the development phase will be considered ready for tests (e.g. Evaluation list for technical performance of system components).

Taking into account SRS’s goals (safety, usefulness, acceptance, intention to adopt... see chapter 4), ad hoc questionnaires tailored for each participants group have been developed to express the issues under investigation; taking care of using a simple language, understandable by elderly people and their relatives (see Appendix 1). They are based on a Likert scale (1 to five scale). After every quantitative question, a qualitative question (“way” question), will be also administered.

Finally, the standard Attrakdiff questionnaire (see Appendix 1) will be filled in by each participant, mainly to complete the evaluation of the attitude, usability and acceptability of the entire system.

At the end of the entire set of experimental sessions, a focus group with the health professionals who conducted and assisted to the experimental session will provide also an expert opinion mainly focusing on safety, ethical and privacy issues.

Users’s validation will be considered achieved if Attrakdiff results would belong at least to the area called “desired” and Questionnaires indicators would reach the threshold of the’ +3,5 “on the 1 to five Likert scale).
However qualitative results will be taken into account to complete and confirm quantitative data emerged from questionnaires.

The table below summarizes the provided Milan tests procedure.

**TABLE 8 THE MILAN TEST PROVIDED PROTOCOL: SUMMARY**

| People to be assessed | ● 20 elderly,  
|                        | ● 20 relatives,  
|                        | ● 10 professionals.  |
| Test session          | ● introduction to participants  
|                        | ● Usability phase  
|                        | ● 3 scenarios experiences  
|                        | ● Users questionnaires administration and technical effectiveness recording  |
| Time needed           | ● 2 to 3 test sessions are provided in one day  
|                        | ● Each session lasting approximately two hours, involving one elderly, one relative and one operator.  
|                        | ● 2/3 days provided for technical arrangement after robot arrival  
|                        | ● 7 full days provided to assess all the provided participants  |
| Indicators:           | → technical indicators  
|                        | ● Evaluation checklist for technical performance (to be provided at the end of integration meetings)  
|                        | → users indicators  
|                        | ● Interactive think-aloud with moderators next to participants  
|                        | ● Ad hoc developed quantitative and qualitative questionnaires  
|                        | ● Standard Attrakdiff questionnaire  
|                        | ● Safety-ethical-privacy issues focus group  |
| Users's validation    | ● Attrakdiff → results belonging to area called “desired”  
|                        | ● Ad hoc questionnaires → indicators threshold ” +3,5 (1 to 5 scale)  
|                        | ● Consideration about Qualitative consideration emerging from think aloud, behavior observations and focus groups  |
| Technical validation  | ● To be defined by technical partners at the end of integration meetings  |
6 FIRST NOTES ABOUT SRS COST EFFECTIVENESS ASSESSMENT & SOCIO-ECONOMIC IMPLICATIONS

Answering to the question: “Is the outcome worth the investment?”, means to take into consideration not only the financial aspect of a product developed for people assistance.

The purchase price is not a meaningful indicator of the social cost. The social cost depends to a large extent on how to use the aid and on the environment, as well as the role of the aid within the whole assistive program. The triad person / activity / environment, as well as determining the criteria for choosing a particular assistive solution, influences the overall social cost.

The most appropriate indicator of the cost of an intervention should take into account:

- The costs are distributed among several actors: social cost could be seen as the sum of costs incurred by all players.
- Some costs have to be considered fixed (independent from the specific chosen product), some other costs instead are marginal (from the specific chosen system for care).
- The cost of the intervention has to be compared with the cost of "non-intervention": what matters is the additional cost.

6.1 IMPLEMENTATION OF THE SIVA COST ASSESSMENT INSTRUMENT (SCAI) IN A MULTI-ROLE ROBOTIC-SYSTEM RESEARCH PROJECT.

SCAI is a specific instrument for social cost analysis designed to help clinicians estimate the economic aspects of providing individual users with assistive technology solutions. It is an informative instrument that, used during clinical assessment, makes clinicians and users aware of the economic consequences of their decisions (Andrich R., 2007). It is designed to help to estimate the cost of choosing a solution for autonomy (aid, personal care, environmental adaptations ...) and to economically compare the various possible solutions.

In most cases, Service Delivery Systems consider just the purchase price of the assistive device, which would seem the most logical indicator to describe whether an AT solution is cheap or expensive. This is not so, since this view often leads to severe distortion of the cost-outcome analysis. SCAI estimates the additional social cost involved by the chosen solution over a certain period of time. This basically includes four cost categories:

- Investment: cost of purchasing the equipment and having it installed, personalised and ready-to-use. This also includes the provision of adequate training for the client.
- Maintenance: running costs of technical maintenance; depending on the case, this may include repairs, insurance, power supply, etc.
- Services: other services that may be needed in relation to the chosen AT solution (e.g., a bulky powered wheelchair might require specialized minibus transport instead of a cheaper ordinary bus).
- Assistance: the amount of human assistance needed in relation to the device (e.g., a pushchair works only if a personal assistant is there to push), independently of whether that manpower is paid for, or offered for free by relatives or friends or volunteers.
In order to better explain the way in which SCAI instruments analyzes social costs, some definitions are needed:

- **Social Cost** The set of all resources used in a certain period of time by all actors involved (e.g., family, National health system facilities, City, volunteering, etc.)

- **Direct Social Cost** The total costs that can be recognized as directly related to the choice of that particular solution

- **Additional Social Cost** Difference between the social cost of intervention, and that in the absence of intervention. This difference can be >0 (investment), zero (moving resources) or <0 (savings)

- **Expenditure** The actual outlay of money by the different ... "co-financing" actors

- **Time horizon** For how many years the costs need to be accounted for:
  - Clinical duration: Within the time horizon, how many years that type of help will be useful to the user
  - Technical duration: lifespan of the system

But what does "non-intervention" with respect to SRS adoption mean? Different options are possible; first of all, simply no help at home, which implies autonomy and ethics consequences; second, a human caregiver at home, which however implies lost of privacy and autonomy all day long

Deliverable 6.2 (expected in month 36), will report the results about social cost analysis at this starting stage. Appendix 3 shows an exemplification of the outcome that such kind of analysis could generate, comparing the social cost of three different kinds of “SRS intervention”, compared with the “non SRS intervention” (i.e. the human 24 hour caregiver).
REFERENCES


8 APPENDIX 1 - DETAILS ABOUT TEST PROTOCOLS AND QUESTIONNAIRES

8.1 MANIPULATION TESTS

SECTION 1. DEMOGRAPHICS AND HEALTH

Demographics

- 1.1. Participant code #:
- 1.2. Gender:
- 1.3. Age:
- 1.4. Date of Birth:
- 1.5. About how many years of education have you completed? ________________
- 1.6. Main occupation during the latest working years: ________________________
- 1.7. Occupational background (How many years have you been working)? ______
- 1.8. Which of the following describes your housing situation (check all that apply):

1. Live alone

2. Live with spouse/partner

3. Live with children

4. Live with other family members or friends

5. Other: ________________________

Frailty

- 2.1. Barber test

2.1.1. Do you live on your own? Yes ___ No ___

2.1.2. Are you without a relative you could call on for help? Yes ___ No ___

2.1.3. Do you depend on someone for regular help? Yes ___ No ___

2.1.4. Are there any days when you are unable to have a hot meal? Yes ___ No ___

2.1.5. Are you confined to your home through ill health? Yes ___ No ___

2.1.6. Is there anything about your health causing you concern or difficulty? Yes ___ No ___

2.1.7. Do you have difficulty with vision? Yes ___ No ___

2.1.8. Do you have difficulty with hearing? Yes ___ No ___

2.1.9. Have you been in hospital during the past year? Yes ___ No ___

Total of Yes responses: ___
2.2. SHARE-FI

2.2.1. EXHAUSTION. In the last month, have you had too little energy to do the things you wanted to do?
Yes ___ No ___

2.2.2. LOSS OF APPETITE. What has your appetite been like?

Diminution in desire for food and / or eating less than usual ___
No change in desire for food and / or eating the same as usual ___
Increase in desire for food and / or eating more than usual ___

2.2.3. WEAKNESS. Maximum grip strength in Kilograms (measured with a hand-held dynamometer):

<table>
<thead>
<tr>
<th></th>
<th>Attempt 1:</th>
<th>Attempt 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right hand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left hand</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2.4. WALKING DIFFICULTIES. Because of a health or physical problem, do you have any difficulty doing any of the following everyday activities? (Exclude any difficulties that you expect to last less than three months)

Walking 100 metres: Yes ___ No ___
Climbing one flight of stairs without resting: Yes ___ No ___

2.2.5. LOW PHYSICAL ACTIVITY. How often do you engage in activities that require a low or moderate level of energy such as gardening, cleaning the car, or doing a walk?

Hardly ever, or never ___
One to three times a month ___
Once a week ___
More than once a week ___

Frailty index ________

Frailty index calculator at http://www.biomedcentral.com/1471-2318/10/57

Cognition

- 3.1. How would you describe your memory capacity comparing to the rest of the society?


- 3.2. How would you describe your actual memory capacity if you compare it with the highest capacity you got in the past?
- 3.3. Mini-Mental State Examination:

___ Time orientation (0-5)
___ Space orientation (0-5)
___ Memory registration (0-3)
___ Attention / calculation (0-5)
___ Delayed memory (0-3)
___ Naming (0-2)
___ Repetition (0-1)
___ Three step command (0-3)
___ Reading (0-1)
___ Writing (0-1)
___ Drawing (0-1)

**SECTION 2: TECHNOLOGY AND SOCIAL SUPPORT**

**Experience with technology**

4.1. Please indicate which technological products or services you use and how frequently you use them.

<table>
<thead>
<tr>
<th>Product</th>
<th>Usage:</th>
<th>Never</th>
<th>at least 1x a day</th>
<th>at least 1x a week</th>
<th>at least 1x a month</th>
<th>rarely</th>
<th>more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing machine</td>
<td></td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Dishwasher</td>
<td></td>
<td>☐</td>
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<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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</table>

4.2. About your experience with technology, you generally feel:
__ Satisfied __ Neutral __ Frustrated

4.3. About your most recent technology experiences, you feel:
__ Positive __ Neutral __ Negative

4.4. About your most recent technology experiences, you feel:
__ Comfortable __ Neutral __ Intimidated

Social support

5.1. About your interaction with family/spouse, you interact:
__ Frequently __ Neutral __ Seldom

5.2. About your interaction with nonfamily/friends, you interact:
__ Frequently __ Neutral __ Seldom

5.3. Do you receive help / care from your family/spouse?
__ Frequently __ Neutral __ Seldom

5.4. Do you receive help / care from nonfamily/friends?
__ Frequently __ Neutral __ Seldom

5.5. Are you satisfied with the help / care you receive?
__ Yes __ No __ Don’t know

5.6. Do you have anyone with whom you can discuss intimate and personal matters? (“Intimate” implies things like sex or family matters, “personal” could include work or occupational issues as well).
__ Yes __ No __ Don’t know

TECHNOLOGY DEMONSTRATION

The robotic arm will be locally controlled by an experienced user by using an already existing local application programming interface (that will imitate the UI_PRO controlling the COB), simulating the way in which a professional user would act and trying to simulate the use of the UI_PRO as much as possible. Tests are going to be based in Scenario 1:

6.1. Demonstration 1: Observation

“The elderly person lies down (i.e. because of backhache). He/she wants some water to take the usual medicine which is already on the nightstand, but the bottle of water instead is placed far from him/her on the table, so he/she uses the robotic arm to bring it closer (…).”

| The robotic arm grasps the object accurately | Comments |
| Errors (frequency) | |
| Need of hints (frequency) | |
| User comments (+ or -) | |
The robotic arm delivers the objects to the target destination

<table>
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<th></th>
<th>Comments</th>
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<tbody>
<tr>
<td>Errors (frequency)</td>
<td></td>
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<tr>
<td>Need of hints (frequency)</td>
<td></td>
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<tr>
<td>User comments (+ or -)</td>
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<tr>
<td>Need of hints (frequency)</td>
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<tr>
<td>User comments (+ or -)</td>
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</table>

Patient reaction

<table>
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<th>Comments</th>
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<tbody>
<tr>
<td>- The patient seems comfortable with the robotic arm</td>
<td></td>
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<tr>
<td>- The patient seems nervous with the robotic arm</td>
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<tr>
<td>- The patient seems scared with the robotic arm</td>
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</table>

Verbal behaviour

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Non-verbal behaviour

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

8.1. Please rate the presented scenarios. Would you use the functionalities?

very unlikely ☐ ☐ ☐ ☐ ☐ very likely

8.2. About the robotic arm, please mark the respective box according to the following statements.

8.2.1. The robotic arm can help me to achieve goals in my daily routine
very unlikely □ □ □ □ □ □ very likely

8.2.2. I would use the system to have more control over my daily life.

very unlikely □ □ □ □ □ □ very likely

8.2.3. I would use the system not to have to do everything by myself.

very unlikely □ □ □ □ □ □ very likely

8.2.4. I would use the system because I like to use these kind of appliances.

very unlikely □ □ □ □ □ □ very likely

8.2.5. I would use this system when it becomes available

totally disagree □ □ □ □ □ □ totally agree

8.2.6. I would buy this system when it becomes available?

totally disagree □ □ □ □ □ □ totally agree
8.2 VISUALIZATION TESTS

SECTION 1. DEMOGRAPHICS AND HEALTH

Demographics

- Participant code #: 1.2. Gender:
- 1.3. Age: 1.4. Date of Birth:
- 1.5. Educative level
  a. Postgraduate (higher) degree
  b. Primary (Bachelor’s) Degree
  c. Diploma or Certificate
  d. Leaving Certificate or equivalent
  e. Group / Intermediate / Junior Cert or equivalent
  f. Primary school or equivalent
  g. No degree yet/still in school
  h. None / Primary not completed
- 1.6. About how many years of education have you completed? ______________
- 1.7. Main occupation during the last years (official title of your job): _____________
- 1.8. Classification of your job
  a. No occupation;
  b. Unskilled laborer;
  c. Housewife;
  d. Skilled laborer, tradesman, lower level civil servant, employee, self-employed small business, officeor sales personal;
  e. Mid-level civil servant or management, head of a small business, academician or specialist in a subordinate position;
  f. Senior civil servant or management, senior academic position, self-employed with high degree of responsibility.
- 1.9 Does your job require mental effort?
  Low mental effort 1 – 2 – 3 – 4 – 5 High mental effort
- Does your job require physical effort?
  Low physical effort 1 – 2 – 3 – 4 – 5 High physical effort
- Does your job require to collaborate with other people?
  Low collaboration 1 – 2 – 3 – 4 – 5 High collaboration
- How many hours a week did you usually work? ______
- How many years have you been working? ______

Health and cognitive processing

- 2.1 Do you have seeing problems? __ Yes __ No
  If yes, which problems? ________________________________________________
- 2.2. Do you have mobility problems? __ Yes __ No
  If yes, which problems? ________________________________________________
- 2.3. Do you have any other problem that could interfere with the use of a laptop?
  __ Yes __ No If yes, which problems? ______________________________________
2.4. Digit – symbol test:
   o Pairing – Score ___
   o Free recall score ___
   o Copy ___

Experience with technology

3.1. Please indicate which technological products or services you use and how frequently you use them.

<table>
<thead>
<tr>
<th>Product</th>
<th>Usage:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
</tr>
<tr>
<td>Washing machine</td>
<td>□</td>
</tr>
<tr>
<td>Dishwaser</td>
<td>□</td>
</tr>
<tr>
<td>Vacuum cleaner</td>
<td>□</td>
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<td>TV</td>
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<td>Telephone</td>
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<td>Smart phone</td>
<td>□</td>
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<tr>
<td>PC or Laptop</td>
<td>□</td>
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</table>

¿For how long have you been using PC or laptop? ____ Years

Other technology (please detail): _______________________________________

3.2. About your experience with technology, you generally feel:

__ Satisfied         __ Neutral         __ Frustrated

3.3. About your most recent technology experiences, you feel:

__ Positive         __ Neutral         __ Negative

3.4. About your most recent technology experiences, you feel:

__ Comfortable      __ Neutral         __ Intimidated

Scenario

This test is going to be conducted with potential professional operators by using the UI_PRO for robot visualization and grasping. In this test, the COB will be simulated on a laptop by means of the UI_PRO. The usage of UI_PRO will be investigated in order to determine if it provides the professional users a tool to control the SRS system.

One of the main features of UI_PRO is in fact its capability to provide a "visualisation of environment". This visualisation will be perceived not only through the cameras of the COB, but will capture also a visualization of the simulated environment by means of the remaining sensors. For example, using only a webcam is very difficult to grasp an object, so 3D info is needed in addition to provide the user a better knowledge of the environment.
The LU asks for a glass of water. So the RO wants to fetch a bottle of water and a glass from the kitchen. He uses a room plan to specify that SRS should go to the kitchen. Having arrived in the kitchen, the RO switches to manual navigation mode and the user manipulates the system in order to accurately grasp the object.

### 4.1 - 1st application

- The user is able to complete the scheduled tasks  
  *Yes / With help / No*  
  Time required: _______
- The robotic arm grasp the object accurately  
  *Agree/Disagree*
- The robotic arm delivers the objects to the target destination  
  *Agree/Disagree*
- The user seems comfortable with the system  
  *Agree/Disagree*
- The user seems scared with the system  
  *Agree/Disagree*

### 4.2 - 2nd application

- The user is able to complete the scheduled tasks  
  *Yes / With help / No*  
  Time required: _______
- The robotic arm grasp the object accurately  
  *Agree/Disagree*
- The robotic arm delivers the objects to the target destination  
  *Agree/Disagree*
- The user seems comfortable with the system  
  *Agree/Disagree*
- The user seems scared with the system  
  *Agree/Disagree*

### 4.3 - 3rd application

- The user is able to complete the scheduled tasks  
  *Yes / With help / No*  
  Time required: _______
- The robotic arm grasp the object accurately  
  *Agree/Disagree*
- The robotic arm delivers the objects to the target destination  
  *Agree/Disagree*
- The user seems comfortable with the system  
  *Agree/Disagree*
- The user seems scared with the system  
  *Agree/Disagree*

<table>
<thead>
<tr>
<th>The robotic arm grasps the object accurately</th>
<th>Comments</th>
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</thead>
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<tr>
<td>Errors (frequency)</td>
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<td>Need of hints (frequency)</td>
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<tr>
<td>User comments (+ or -)</td>
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<td></td>
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<tr>
<td>User comments (+ or -)</td>
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Instructor notes

Verbal behaviour  
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
Non-verbal behaviour
### Accessibility and Usability

8.1. Please rate the presented scenario. Would you like to use the functionalities?

<table>
<thead>
<tr>
<th></th>
<th>Definitely yes</th>
<th>Rather yes</th>
<th>Maybe</th>
<th>Rather not</th>
<th>Definitely not</th>
</tr>
</thead>
</table>

8.2. I find the system easy to use.

<table>
<thead>
<tr>
<th></th>
<th>Definitely yes</th>
<th>Rather yes</th>
<th>Maybe</th>
<th>Rather not</th>
<th>Definitely not</th>
</tr>
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</table>

8.3. How well did you think the system show actual location of the robotic arm?

<table>
<thead>
<tr>
<th></th>
<th>1: Very bad</th>
<th>2: Bad</th>
<th>3: Undecided</th>
<th>4: Well</th>
<th>5: Very well</th>
</tr>
</thead>
</table>

8.4. Is it easy to make the software do exactly what I want?

<table>
<thead>
<tr>
<th></th>
<th>Definitely yes</th>
<th>Rather yes</th>
<th>Maybe</th>
<th>Rather not</th>
<th>Definitely not</th>
</tr>
</thead>
</table>

8.5. I perceive perfect control over the activity of the system.

<table>
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<tr>
<th></th>
<th>Definitely yes</th>
<th>Rather yes</th>
<th>Maybe</th>
<th>Rather not</th>
<th>Definitely not</th>
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</table>

### Learnability

6.1. To learn to use this system would be easy for me.

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<tr>
<th></th>
<th>Definitely yes</th>
<th>Rather yes</th>
<th>Maybe</th>
<th>Rather not</th>
<th>Definitely not</th>
</tr>
</thead>
</table>

6.2. It would be easy for me to learn skilful use of this system.

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<tr>
<th></th>
<th>Definitely yes</th>
<th>Rather yes</th>
<th>Maybe</th>
<th>Rather not</th>
<th>Definitely not</th>
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</table>

6.3. It is easy to forget how to do things with this system.

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<th></th>
<th>Definitely yes</th>
<th>Rather yes</th>
<th>Maybe</th>
<th>Rather not</th>
<th>Definitely not</th>
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6.4. Working with this system could be mentally stimulating.

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<th></th>
<th>Definitely yes</th>
<th>Rather yes</th>
<th>Maybe</th>
<th>Rather not</th>
<th>Definitely not</th>
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Acceptance

About the robotic arm, please mark the respective box according to the following statements.

- Usability perception

  7.1. The robotic arm can help to help frail older adults with their daily routines

    very unlikely  □  □  □  □  □  □  very likely

  7.2. I perceive the use of the robotic arm can help me to control over the difficulties of the daily users.

    totally disagree  □  □  □  □  □  □  totally agree

- Accessibility perception

  7.3. This system would make my work easier.

    very unlikely  □  □  □  □  □  □  very likely

  7.4. This system would make my work more interesting.

    very unlikely  □  □  □  □  □  □  very likely

- Intention to use

  7.5. I would use the system because I like to use such appliances.

    very unlikely  □  □  □  □  □  □  very likely

  7.6. I would use the system because these appliances are modern.

    very unlikely  □  □  □  □  □  □  very likely

  7.7. I would use the system to keep up with the newest technology.

    very unlikely  □  □  □  □  □  □  very likely

  7.8. In general, I would like to use this system when it becomes available

    totally disagree  □  □  □  □  □  □  totally agree
8.3 ADVANCED SRS PROTOTYPE TESTS- AD HOC QUESTIONNAIRES

Overall indicators about fulfilling of users’s requirements, usefulness, usability, acceptance, intention to adopt

**Elderly people’s questionnaire**

1. I think that SRS would Make it **easier** to perform some activities of daily living
   
   totally disagree ☐ ☐ ☐ ☐ ☐ ☐ totally agree
   
   Why?............................................................................................................................................

2. I think that SRS would make it **safer** to run some activities of daily living
   
   totally disagree ☐ ☐ ☐ ☐ ☐ ☐ totally agree
   
   Why?............................................................................................................................................

3. I think that SRS would put me in a position to perform certain tasks without having to wait for someone to come to my house (autonomy)
   
   totally disagree ☐ ☐ ☐ ☐ ☐ ☐ totally agree
   
   Why?............................................................................................................................................

4. Having SRS at home, I would **feel more independent**
   
   totally disagree ☐ ☐ ☐ ☐ ☐ ☐ totally agree
   
   Why?............................................................................................................................................

5. Having SRS at home, I would **feel less afraid** of being at home alone
   
   totally disagree ☐ ☐ ☐ ☐ ☐ ☐ totally agree
   
   Why?............................................................................................................................................

6. With SRS, I’m **confident** that every request is immediately taken in consideration (considering first family and then a teleassistance service always available)
   
   totally disagree ☐ ☐ ☐ ☐ ☐ ☐ totally agree
   
   Why?............................................................................................................................................

7. Having SRS at home, I **wouldn’t feel too much controlled** (privacy/ethic)
   
   totally disagree ☐ ☐ ☐ ☐ ☐ ☐ totally agree
   
   Why?............................................................................................................................................

8. Having SRS at home, I **would be worried** to break the system
   
   totally disagree ☐ ☐ ☐ ☐ ☐ ☐ totally agree
   
   Why?............................................................................................................................................
9. Having SRS at home, I **would be worried** that the robot could **break something** in my home  
totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?.................................................................................................................................

10. I found the robot **useful**  
totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?....................................................................................................................................

11. I’m satisfied with how the **robot looks**  
totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?....................................................................................................................................

12. I’m satisfied with the **robot size**  
totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?....................................................................................................................................

13. It was **fun** to interact with the robot  
totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?....................................................................................................................................

14. I **could effectively** use the robot to contact people and receive assistance  
totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?....................................................................................................................................

15. I **could effectively** use the robot to execute simple tasks by myself  
totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?....................................................................................................................................

16. I’m satisfied with the **time it took** to complete the task using the robot  
totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?....................................................................................................................................

17. I’m satisfied with the **usability of the interface**  
totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?....................................................................................................................................

18. I **would like** to use the **SRS** system if it is available  
totally disagree ☐ ☐ ☐ ☐ ☐ totally agree
19. I would like to buy the SRS system as soon as it is available
   totally disagree □ □ □ □ □ totally agree
   Why?..........................................................................................................................

20. I think that SRS would make easier to perform some activities of daily living for my assisted
   totally disagree □ □ □ □ □ totally agree
   Why?..........................................................................................................................

21. I think that SRS would make easier to better check the health status of my assisted
   totally disagree □ □ □ □ □ totally agree
   Why?..........................................................................................................................

22. I think that SRS would make safer to run some activities of daily living for my assisted
   totally disagree □ □ □ □ □ totally agree
   Why?..........................................................................................................................

23. I think that SRS would put me in a position to help my assisted to perform certain tasks without making him/her to wait for someone to come to his/her house (autonomy)
   totally disagree □ □ □ □ □ totally agree
   Why?..........................................................................................................................

24. I think it would give me the possibility to get more things done in a day (e.g. stay at work and help my assisted)
   totally disagree □ □ □ □ □ totally agree
   Why?..........................................................................................................................

25. I think it would make me saving time
   totally disagree □ □ □ □ □ totally agree
   Why?..........................................................................................................................

26. With SRS, I would feel more free
   totally disagree □ □ □ □ □ totally agree
   Why?..........................................................................................................................

27. With SRS, I would feel less afraid of leaving my assisted at home alone
totally disagree  ☐  ☐  ☐  ☐  ☐  totally agree

Why?............................................................................................................................................................

28. With SRS, I’m confident that every request is immediately taken into consideration by someone and completed
(chain: family or 24 hour tele assistance)

totally disagree  ☐  ☐  ☐  ☐  ☐  totally agree

Why?............................................................................................................................................................

29. I found the robot useful

totally disagree  ☐  ☐  ☐  ☐  ☐  totally agree

Why?............................................................................................................................................................

30. It was fun to control the robot

totally disagree  ☐  ☐  ☐  ☐  ☐  totally agree

Why?............................................................................................................................................................

31. I’m satisfied with the time it took to complete the tasks using the robot

totally disagree  ☐  ☐  ☐  ☐  ☐  totally agree

Why?............................................................................................................................................................

32. I could effectively use the robot to contact my assisted and give assistance

totally disagree  ☐  ☐  ☐  ☐  ☐  totally agree

Why?............................................................................................................................................................

33. I’m satisfied with the usability of the interface

totally disagree  ☐  ☐  ☐  ☐  ☐  totally agree

Why?............................................................................................................................................................

34. I would use the SRS system if it was available

totally disagree  ☐  ☐  ☐  ☐  ☐  totally agree

Why?............................................................................................................................................................

35. I would like to buy the SRS system as soon as it will be available

totally disagree  ☐  ☐  ☐  ☐  ☐  totally agree

Why?............................................................................................................................................................

Professional operators’ questionnaire
36. I think that SRS would make easier to better check the health status of my assisted (also having possibility to see the person)

totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?

37. I think that SRS would put me in condition to better manage an emergency

totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?

38. I think that SRS would make safer to run some activities of daily living for my assisted

totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?

39. I think that SRS would put me in a position to help my assisted to perform certain tasks without making him/her to wait for someone to come to his/her house (autonomy)

totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?

40. I found the robot useful

totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?

41. I found the system easy to use

totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?

42. I found that the system correctly show actual location of the robotic arm

totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?

43. I perceived perfect control over the activity of the system

totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?

44. I’m satisfied with the time it took to complete the tasks using the robot

totally disagree ☐ ☐ ☐ ☐ ☐ totally agree

Why?

45. I could effectively use the robot to contact my assisted and give assistance
totally disagree □ □ □ □ □ □ totally agree

Why?..............................................................................................................................................

46. I’m satisfied with the usability of the interface

totally disagree □ □ □ □ □ □ totally agree

Why?..............................................................................................................................................

47. This system would make my work easier.

totally disagree □ □ □ □ □ □ totally agree

Why?..............................................................................................................................................

48. This system would make my work more interesting.

totally disagree □ □ □ □ □ □ totally agree

Why?..............................................................................................................................................

49. I would like to use the SRS system if it was available in my service

totally disagree □ □ □ □ □ □ totally agree

Why?..............................................................................................................................................

8.4 Attrakdiff User Experience Questionnaire

<table>
<thead>
<tr>
<th>Attractiveness</th>
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<tr>
<td>Perspicuity</td>
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<td>difficult to learn</td>
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<td>exiting</td>
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<td>Feature</td>
<td>Rating</td>
<td>Why</td>
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<td>-------------</td>
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<td>----------</td>
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<tr>
<td></td>
<td>why:</td>
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<td></td>
<td>why:</td>
<td></td>
</tr>
<tr>
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<td>1 – 2 – 3 – 4 – 5 – 6 – 7</td>
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<td></td>
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</tr>
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<td></td>
<td>why:</td>
<td></td>
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<tr>
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<td>usual</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Dependability</td>
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<td>1 – 2 – 3 – 4 – 5 – 6 – 7</td>
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<td></td>
<td>why:</td>
<td></td>
</tr>
<tr>
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<td></td>
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<td>meets expectations</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7</td>
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<td></td>
<td>why:</td>
<td></td>
</tr>
<tr>
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<td>inefficient</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7</td>
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<tr>
<td>Perspicuity</td>
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<td>1 - 2 - 3 - 4 - 5 - 6 - 7</td>
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<td>------------</td>
<td>-------</td>
<td>--------------------------</td>
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<td>1 - 2 - 3 - 4 - 5 - 6 - 7</td>
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<tr>
<td>Efficiency</td>
<td>organized</td>
<td>1 - 2 - 3 - 4 - 5 - 6 - 7</td>
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<td>Attractiveness</td>
<td>attractive</td>
<td>1 - 2 - 3 - 4 - 5 - 6 - 7</td>
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<td>sympathisch</td>
<td>1 - 2 - 3 - 4 - 5 - 6 - 7</td>
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<tr>
<td>Attractiveness</td>
<td>friendly</td>
<td>1 - 2 - 3 - 4 - 5 - 6 - 7</td>
</tr>
<tr>
<td>Novelty</td>
<td>conservative</td>
<td>1 - 2 - 3 - 4 - 5 - 6 - 7</td>
</tr>
</tbody>
</table>
9 APPENDIX 2- SCENARIOS SCREENPLAY

The scenarios screenplay will be translated in Italian language and given to each participant to enable them to execute the scenarios.

9.1 SCENARIO 1 - SITUATION MONITORING AND BASIC FETCH AND CARRY

Actors:

LU (elderly man or woman)
RO-PRI (private remote operator: relative or other who usually take care for the elderly)

RO-PRI To check if everything is alright at LU’s home, RO, initiates from his/her workplace a request for a remote session with SRS during a pause.

LU accepts the request on the portable communication device and the video communication is established. LU states that today is not feeling well, unable to get up to reach some water to take the medicine already located on the bedside table.

RO-PRI sends the robot to the kitchen, make it bringing a glass and a bottle of water to take it to LU

LU- RO-PRI They greet each other and agree to contact each other later
9.2 Scenario 2 - Emergency Assistance Chain

Actors:

LU (elderly man or woman)
RO-PRI (private remote operator: relative or other who usually take care for the elderly )
RO-PRO (potential professional remote operator of a tele assistance center)

LU watches TV. In the commercial break, LU wants to go to the bathroom but LU feels bad on the way, falling* (*just simply sitting down on a chair on the way in the test, or if the elderly is already on a wheelchair, just simulating to need for some help) unable to get up again.

With a device LU always carries attached to the belt, LU calls for RO-PRI.

RO-PRI is not available at the moment

LU decides to call the 24 hour centre so she presses a button “emergency”. Right away, a call is placed to the 24-hour teleassistance center.

The device asks Elisabeth for her current position and she selects the room from a list.

SRS starts moving from its charging station to the room where Elisabeth fell. *function maybe not implemented

RO-PRO The 24-hour center first accepts the call. Because LU can no longer move the legs due to strong pain, the two decide to call an ambulance. RO-PRO keeps talking to LU until someone arrive at home.

Through SRS’s camera, RO_PRO, can see LU on the floor and asks what happened. She uses manual navigation to further drive the robot to the place where Elisabeth lies and to point the robot’s camera more downwards. *function maybe not implemented

RO-PRI who finished a work meeting saw the missed call from LU and joins the remote session just to reassure LU that he/she is already coming over in person.
9.3 **Scenario 3 - Fetch and carry of “difficult” objects**

**LU** (elderly man or woman)
**RO-PRO** (potential professional remote operator of a teleassistance center)

LU does not feel safe climbing a ladder. LU has an SRS system to help him/her with difficult objects. Since LU has no cognitive deteriorations, he/she usually handles SRS him/herself, only falling back to a teleoperator in case it fails to execute an interaction with SRS. LU wants to fetch a book on a shelf.

after several failed attempts, he gives up (the book is surrounded by other things causing problems with the collision-free path planning for the arm).

LU doesn’t want to disturb a relative for this task, knowing that they are all at work, so LU calls directly for a professional remote operator

RO-PRO answers the call, greets LU and asks LU to explain what he/she would like to do.

LU explains that he/she was not able to fetch the desired book

RO-PRO uses the professional manual mode to grasp the book and bring it to LU. They greet each other and the call ends.
10 APPENDIX 3 – SCAI ANALYSIS: AN APPLICATION EXAMPLE

SRS Objective: enable elderly people to continue to live at own home.

Costs include: equipment, maintenance, related services, human assistance

Costs are expressed in euro, SRS purchasing price and Government contributions are completely invented just to show a concrete example of SCAI instrument usage.

Human assistance can be: Level A: anybody; Level B: strength; Level C: professional

Costs of human assistance are based on Italian current values

Solution 1:

Elder living alone at his home, Robot purchased, and 24 hour service

<table>
<thead>
<tr>
<th>Solution 1</th>
<th>SRS ROBOT and 24 hour service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase Price</td>
<td>20000</td>
</tr>
<tr>
<td>Direct social cost in 10 years</td>
<td>96000</td>
</tr>
<tr>
<td>User expenditure</td>
<td>76,500</td>
</tr>
<tr>
<td>National health system expenditure</td>
<td>18000</td>
</tr>
<tr>
<td>Tax recovery</td>
<td></td>
</tr>
<tr>
<td>Total expenditure in 10 years</td>
<td>96000</td>
</tr>
</tbody>
</table>

Ipothesys: technical duration 10 years
Assistance level B: 18 €/hour

Economic elements:
- Robot € 20000
- Energy/Maintenance 200 €/anno
- 24 hour service assistance: 6480 €/year

Financial elements:
- Robot purchasing (20000€) +
- 24 hour service (6480) +
- Maintenance -
- Government Contribution

Solution 2

Elder living alone at his home, Robot for rent, and 24 hour service
Solution 3:

Elder living alone at his home, Robot purchased, relative RO

<table>
<thead>
<tr>
<th>Solution 3</th>
<th>SRS for rent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase Price</td>
<td></td>
</tr>
<tr>
<td>Direct social cost in 10 years</td>
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</tr>
<tr>
<td>User expenditure</td>
<td>116800</td>
</tr>
<tr>
<td>National health system expenditure</td>
<td>10000</td>
</tr>
<tr>
<td>Tax recovery</td>
<td></td>
</tr>
<tr>
<td>Total expenditure in 10 years</td>
<td>126800</td>
</tr>
</tbody>
</table>

Ipothesys: technical duration 10 anni
Assistance level B: 18 €/hour

Economic elements:
- Robot for rent and 24 hour service (6000 €/year plus 6480 €/year)
- Maintenance and energy (200 €/year)

Financial elements:
- Robot rent and service +
- Maintenance -
- NHS Contribution

Solution 4:

<table>
<thead>
<tr>
<th>Solution 4</th>
<th>SRS relative RO</th>
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</thead>
<tbody>
<tr>
<td>Purchase Price</td>
<td>20000</td>
</tr>
<tr>
<td>Direct social cost in 10 years</td>
<td>8.800</td>
</tr>
<tr>
<td>User expenditure</td>
<td>12000</td>
</tr>
<tr>
<td>National health system expenditure</td>
<td>10000</td>
</tr>
<tr>
<td>Tax recovery</td>
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</tr>
<tr>
<td>Total expenditure in 10 years</td>
<td>22000</td>
</tr>
</tbody>
</table>

Ipothesys: technical duration 10 anni
Assistance level B: 18 €/hour

Economic elements:
- Robot € 20000
- Energy/Maintenance 200 €/anno
- Relatives assistance: 6480 €/year

Financial elements:
- Robot purchasing (20000 €) +
- Maintenance -
- NHS Contribution -
- Government Contribution =
non-intervention with SRS robot: caregiver 24 hours at home with elderly

Hypothesis of non-intervention: caregiver 24 hours at home with elderly (Assistance level A - 12 €/hour)

<table>
<thead>
<tr>
<th>Economic elements:</th>
<th>Financial elements:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caregiver at home, 22 hours work every day (1200 €/month)</td>
<td>-</td>
</tr>
<tr>
<td>User expenditure</td>
<td>Government contribution</td>
</tr>
</tbody>
</table>

A Comparative analysis between solutions considering the solution “caregiver at home” as “non intervention” would bring to this conclusion: all the proposed solution of SRS interventions appear to be less expensive in terms of socio-economic impact compared with the “non intervention”.

<table>
<thead>
<tr>
<th>Solution 4</th>
<th>24 hour caregiver</th>
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</thead>
<tbody>
<tr>
<td>Purchase Price</td>
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<tr>
<td>Direct social cost in 10 years</td>
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<tr>
<td>User expenditure</td>
<td>100.000</td>
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<tr>
<td>National health system expenditure</td>
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</tr>
<tr>
<td>Government expenditure</td>
<td></td>
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<tr>
<td>Tax recovery</td>
<td></td>
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<td>Total expenditure in 10 years</td>
<td>144.000</td>
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<tr>
<td>Solutions</td>
<td>SRS ROBOT and 24 hour service</td>
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<tr>
<td>-----------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Purchase Price</td>
<td>20000</td>
</tr>
<tr>
<td>Direct social cost in 10 years</td>
<td>86800</td>
</tr>
<tr>
<td>User expenditure</td>
<td>76.800</td>
</tr>
<tr>
<td>National health system expenditure</td>
<td>10000</td>
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<td>Tax recovery</td>
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</tr>
<tr>
<td>Total expenditure in 10 years</td>
<td>86800</td>
</tr>
</tbody>
</table>

Additional cost

- Cost of "intervention"
- Cost of "non intervention"

\[
\begin{align*}
\text{Additional cost} &= 86800 - 144000 = -57200 \\
&= 126800 - 144000 = -17200 \\
&= 22000 - 144000 = -122000
\end{align*}
\]