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D 2.3 Long-Term Evaluation: Test sites Results

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Deliverable Summary

This deliverable describes the final results of the evaluation activities of the ExCITE project. In particular, the document depicts the *long-term* evaluation, which entails the usage of Giraff in real living environments for long periods of time (up to 1 year).

The report describes the methodology conceived for the long-term assessment and report the final results gathered from all the test sites in Sweden, Spain and Italy. For some of the test sites we had to slightly adapt the common methodology or to use a different one developed on purpose in order to both capture the specificity of the case and meet users' specific requests. Nevertheless useful feedback emerged by all the test sites and contributed to iteratively improve the Giraff prototype. In this respect this document is conceived as an update of Deliverable D2.3 (M24), to give the complete picture of the results after the long period of assessment. The results from the long term evaluation indicate that performing longitudinal studies is a feasible approach even for products early in its development and that in general different categories of end users were positive towards the technology. The studies also revealed some important caveats to testing with real users longitudinally, such as the difficulty of performing rigorous and controlled questionnaires over months/years, the impact that technical errors characteristic of prototypes have on evaluation and the challenge of capturing all possible external factors which impact the perceptions of end users.

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1 Introduction

The idea behind the ExCITE project is to assess the robustness and validity of the Giraff telepresence robotic platform as a means to support elderly and to foster their social interaction and participation. The main driving concepts of the project are the following:

- *User centered product refinement*, this approach is based on the idea of obtaining users feedback during the time they use the robot and cyclically refine the prototype in order to address specific needs;
- *User tests outside labs*, rather than testing the system in a laboratory setting, the robotic platform is placed in a real context of use. This approach is in line with several other studies that highlight how systems that work well in the lab are often less successful in real world environments (e.g. Sabanovic et al., 2006). The evaluation of robots made in a laboratory environment, even though useful, does not favor the emergence of robotic aid suitability to support elders who are able to stay in their own homes. For this reason, an essential step is to assess the technology in the specific contexts in which the technology is supposed to be used (Hutchins, 1995);
- *Use on a time period long enough*, to allow habituation and possible rejection to appear. Indeed, interviews and survey conducted after a short period of time can be limited and can prevent other effects to emerge (Bickmore and Picard, 2005). In this light, in order to assess the human-robot interaction, it is important also to investigate how people interact with robots over long periods of time.

Figure 1 gives a brief sketch of the whole idea that has been pursued along the project: several Giraff prototypes have been deployed for long periods of time (at least three months up to 1 year) in three different countries (Italy, Spain and Sweden) in real contexts of use. Feedback obtained from the users (both older users having the robot at home and the clients, that is people connecting and visiting the older) has been used to technically improve the robot.

Additionally, several human-robot interaction aspects have been considered and monitored over time, to study the impact of the robotic technology use on the participants.

This deliverable summarizes the main results of this effort and highlights the human-robot interaction studies that have been performed. Additionally, the feedback received by participants at the test sites have been iteratively fed to the technicians for inspiring the technological improvements of the Giraff robot and also to influence the business plan D7.3.
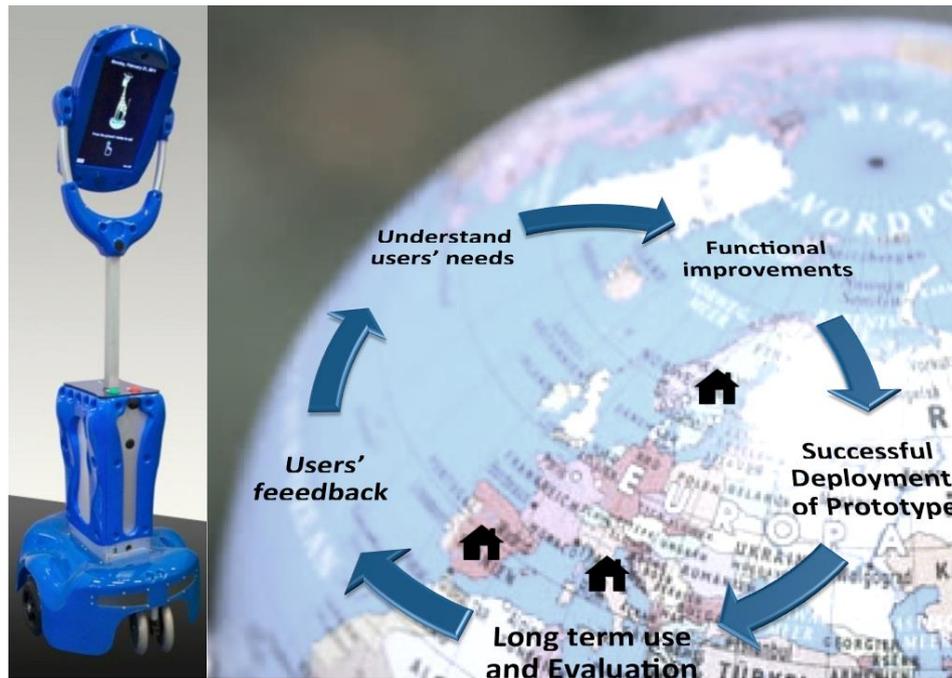
Figure 1 The ExCITE approach

1.1   Scope of the document

The aim of this document is to describe the final results of the work performed in the user evaluation and test sites activities. More specifically, the first version of the deliverable (D2.3 M24) was concentrated on two aspects: 1) the feedback from test sites that served to support the iterative development approach and 2) the studies related to the Human Robot Interaction (HRI) aspects. This updated version mainly complements the work partially described in Deliverable D2.3 Report (M24) that contained the history and description of the test sites. Specifically, the test sites continued to generate feedback for suggesting improvements that has been translated into updated recommendations described in D2.2 M24 and M36. This deliverable on the contrary mainly focuses on the description of the psychosocial studies on the impact of Giraff in the long-term usage on from older users and their careers.

1.2   Deliverable structure

The deliverable is organized as follows: Section 2 recalls the common methodology conceived for the long-term assessment of all test sites; Section 3 presents an overview of the ExCITE's test sites; Section 4, Section 5 and Section 6 presents the detailed results from each of the test sites performed in the three countries (Sweden, Spain and Italy respectively). Section 7 presents the feedback obtained by additional test sites that did not completely follow the conceived evaluation plan; Section 8 presents a critical summary of the results obtained through the long-term evaluation providing conclusive considerations.

2   Long-Term evaluation

2.1   Design of a common methodology

One of the original features of the EXCITE project consists of realizing a long-term user evaluation involving older adults using Giraff in their normal environment both to communicate with other persons and to receive assistance services. In this perspective, the project entailed the instantiation of several case studies in three countries and the creation of an evaluation plan, based on interviews and questionnaires to be administered to the older persons (end users) and to the family members, friends and caregivers (clients).

Designing the evaluation with different types of users and situations entailed an effort to prepare materials and adjust the procedure according to the specific case. For this evaluation, we distinguish among situations in which the elderly interacts with a health care institution (formal care giver), a family member caring for the elderly (informal caregiver), and a family member or friend who interacts solely for social purposes. The three situations have been distinguished because the type of questions for both the client and the end user depend upon the type of interaction for which Giraff is used.

Figure 2 gives a general idea of the designed method to evaluate features over time. The evaluation entails a period of N months (with $3 \leq N \leq 12$) during which the end user has the robot at home and the clients can visit him/her through it. Assessment happens at milestones S_i. Specifically, after an initial assessment (S_0 in figure) at the beginning of the experimentation (baseline), the variables of interest are measured at regular intervals (S_{1-3}) to observe changes over time. At the last month, the Giraff is removed from the end user apartment a follow-up assessment if performed after 2 months from this removal (S_4). The general idea is to use a repeated measures method to see changes over time during the long-term use experience of the telepresence robotic system.

Figure 2 The Long-term Evaluation timeline of ExCITE

2.1.1   Participants and Procedure

As already mentioned, three different cases have been identified to cover different situations in which the robot can be deployed. Specifically, for the secondary user typology we considered (a) a formal caregiver belonging to a Health care organization; (b) a family member (informal caregiver); (c) other relatives or friends who may visit the elderly person through the robot. The type of material used in the long-term evaluation for both the client and the end user depends upon the type of interaction for which the telepresence robot is used. For this reason, we had developed (or selected) a set of questionnaires (almost all validated in the three languages of the involved

countries) for each of the three mentioned situations. These questionnaires aimed at monitoring specific variables and to be administrated at specific time both to end users and to clients.

2.1.2 Material

Figure 3 lists the different variables and the related instruments to be used to measure the variables over time. The specific questionnaires used are specified as in the following paragraph. A detailed table is also available in Table 3 in D2.3 M24.

2.1.2.1 Client side

Specifically on the client side, during the initial step (S0), we use: (a) an informed consent form describing the aim and procedure of the study; (b) the socio-demographic data form to gather some relevant information on the user; (c) a for ExCITE developed questionnaire aiming at assessing the client's expectations on the Giraff's ability to ease the support (Support Expectation). It is worth highlighting that we developed two slightly different types of questionnaires for the formal and informal caregivers, while for the other relatives and friends category we designed a questionnaire (Influence on Relationship Expectation) on the expectations on Giraff as a means to ease and support the remote communication and consequently the social relationship.

During the following step (S1), we use: (a) System Usability Scale (SUS) (Sauro and Lewis, 2012) to assess the usability of the client software; and (b) an ad hoc questionnaire (Difficulty and Ease of learning and use of functions 'and commands' interface), which assesses the ease / difficulty of learning and using the features and commands of the interface. Further we ask each participant to keep a diary to register the "salient" events of the visit through telepresence in terms of encountered problems, good features and so on. The questionnaires used are the same for all three types of secondary users introduced above.

During the subsequent step (S2), in addition to the diary that clients have to keep along the whole experience with the robot, we make a first assessment of the Giraff's ability to ease the support (or the communication) between the client and the end user through the Support Assessment and Impact on Relationship Assessment questionnaires. In addition, during this phase we also explore telepresence dimensions through an adaptation of the Temple Presence (Lombard & Ditton, 1997) and Networked Minds Social Presence Inventories (Harms & Biocca, 2004)) that are specific tools to measure dimensions of (tele)presence. At step S3, we use the Positive Affect Negative Affect Scale, PANAS, (Terracciano et al, 2003), the Psychosocial Impact of Assistive Devices Scale, PIADS, (Jutai, 2002) and a final structured interview to assess the overall experience in terms of the most relevant variables considered in the study. After two months from the robot removal, S4 allows assessing the impact of its absence through the Support Expectations *or* Influence on Relationship Expectations ad hoc questionnaire.

2.1.2.2 End user side

For the end user receiving the robot, we followed a similar approach, However, we focused on some additional variables that is worth dwelling on (see Figure 3). Specifically, we measure: (a) the perceived loneliness through the UCLA Loneliness Scale (Russell et al., 1980), which was developed to assess subjective feelings of loneliness or social isolation; (b) the perceived health status through the Short Form Health Survey (SF12) (Ware et. al., 1996); (c) the Multidimensional Scale of

Perceived Social Support (Zimet, 1988); and (d) Geriatric Depression Scale (Yesavage et. al., 1983): a modified version of the Health Service Satisfaction Inventory. Finally, the Almere (Heerink et al., 2010) model that allows assessing dimensions of technology acceptance.

In Figure 3, measures highlighted in bold ensure the repeated measures thus allowing to observe the Giraff's influence by changes in response over time. In fact, it is worth underscoring how this evaluation plan allows monitoring the human-robot interaction over time, thus contributing to understand the long-term impact of a fully deployed robotic that is the support for elderly persons.

S0
- **End user:** Consent form - Socio Demographics data form - UCLA - SF12 - MSPSS - GDS - Robot   Acceptance
- **Pilot user**: Consent form - Socio Demographics data form - Expectations questionnaire

S1
- **End user:** UCLA - SF12 - MSPSS - GDS - Attitude and general evaluation towards the robot
- **Pilot user**: System Usability Scale - Ease/Difficulty of learning and use functions'and commands' interface

S2
- **End user:** Telepresence Dimensions - Robot Acceptance
- **Pilot user**: Expectations assessment questionnaire - Telepresence Dimensions - Ease/ Difficulty of learning and use functions' and commands' interface

S3
- **End user:** UCLA - SF12 - MSPSS - GDS - Robot Acceptance - PIADS - PANAS
- **Pilot user**: PIADS - PANAS

S4
- **End user:** UCLA - SF12 - MSPSS - GDS
- **Pilot user:** Expectations questionnaire follow up

Figure 3 Long-term evaluations: variables measured along the phases (S0-S4) and related material

The majority of test sites have followed this methodology. Nevertheless, in some cases, due to the specificity of the test sites and the need for preserving the right of participants to only answer to questions they were confortable with, or to the personal conditions of participants we had to follow slightly different protocols.

In the next sections (Section 4, Section 5 and Section 6), we first describe the results of the test sites that generally followed the evaluation plan described in this section by introducing results per country. In Section 7, we present results from the remaining test sites that also contributed to provide useful insights both for the prototype development and for the HRI studies.

3   An overview of ExCITE's Testsites

In this Section we provide the reader with an overview of the testsites in the project. First, we provide a 'bird's eye' view of each of the testsites that were tried in ExCITE per country. Then for each country, we give more detail according to the different specifications of each testsite. We use the notion of "Successfully Ended" "Prematurely Ended" and "On-going" in the previous deliverable. Since then, however, the consortium has come to realise that all testsites, with the exception of very few, have in fact provided valuable feedback and information. Therefore, we now use the notion of "Full Evaluation Cycle" and "Partial Evaluation Cycle". A full evaluation cycle involves completion of all questionnaire tools. Partial Evaluation Cycle involves completion of sets of questionnaires or the use of other tools e.g. diary or logbook in order to gather information and data. The reason why exactly the same set of questionnaires was used at all test site emerged from the fact that each testsite differed. For example as shown in the overview, some testsites were located in rehabilitation centers or in building complexes. Here, it was not meaningful to apply the full evaluation cycle. In the following Section we focus on the data from the Full Evaluation Cycle Testsites.

3.1   Testsite Timing and Overview

The following 3 graphs (Figure 4-6) presented in Subsections 3.2, 3.3 and 3.4 indicate the Overview for each testsite. The testsite names are on the y-axis and the month and duration is indicated on the upper x-axis. Each testsite consisted of a number of end-users. Primary end-users are located on the left of each testsite and belong to the category of single female, single male, couple (female+male), living complex, rehab/care facility. The right hand side indicates the secondary user and can be combinations of healthcare professionals, family, researchers. The bars, which are indicated in blue, are the testsites which underwent the full evaluation cycle and that are further described in detail in this deliverable. The Table 1 below provides a legend on how to read the overview graphs.

Symbol	Meaning
	Female Primary User
	Male Primary User
	Family Member
	Health Care professional(s)
	Researcher
	Larger living facility, where several appts use one Giraff.
	Rehab/Care center

Table 1 Legend to read the test sites overview graphs

3.2 Test Sites in Sweden

In Sweden, a total of 7 testsites have been deployed. These testsites vary in composition. Those testsites where family members were involved usually had family members that were located in other geographical locations. The further family member was occurred in a Swedish testsite where the son was located in the Fiji Islands.
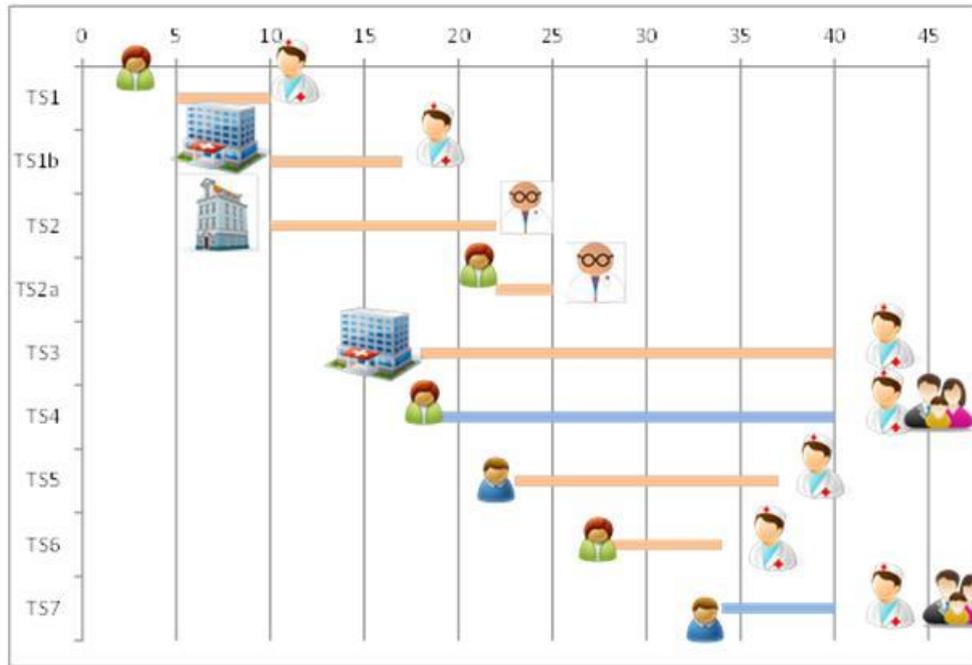
Figure 4 Summary of test sites deployed in Sweden

Further information about each testsite is given below. Additional notes, which describe the testsites, are also provided. The reasons for ending a testsite is given. As seen, these reasons vary. In Sweden, the reasons were less due to emotional factors but rather physical problems, which occurred with the primary user. One testsite also failed due to technical difficulties in the infrastructure, this testsite provided interesting and valuable information for WP5 as these difficulties were related to the communication infrastructure. One testsite was a longitudinal site at a rehab center. This testsite was highly instrumental in creating the subsequent testsites that underwent the full evaluation cycle.

TestSite_Sweden_1(a)				
Type	**Start Date**	**End Date**	**Location**	**Status**
Private Residence	November 2010	March 2011	Rural area, Örebro Sweden	**Partial Evaluation Cycle**
Primary End User	The first test site in Sweden was the home of an elderly couple in Örebro. The wife received assistance from professional home help and her home was equipped with an alarm service. She was the intended user of the Giraff.			
Secondary End User	The Giraff was used by her city council, Örebro City Council, and alarm central company (Tunstall AB) to contact the couple. A total of 32 persons that could be contacting the couple via Giraff received a short course on how to use the Giraff. They also filled questionnaires after the trials to collect their first impressions of the Giraff.			

Additional Comments	The test site was started in November 2010 and unfortunately the wife passed away in March 2011. The husband did not want to keep anything that reminded him of the wife.

TestSite_Sweden_1(b)

Type	Start Date	End Date	Location	Status
Rehabilitation center	March 2011	November 2011	city, Örebro Sweden	**Partial Evaluation Cycle**
Primary End User	People in need of rehabilitation after e.g. strokes visit the rehabilitation center regularly (1-2 times per week).			
Secondary End User	Occupational therapist connects to the Giraff and interacts with the elderly.			
Additional Comments	Interaction takes place during coffee breaks as well as during actual training. A questionnaire based on the Almere model was used to evaluate the elderly's perception of the Giraff at the rehabilitation center.			

TestSite_Sweden_2

Type	Start Date	End Date	Location	Status
Elderly residential home	March 2011	March 2012	Töre (rural area North of Sweden)	**Partial Evaluation Cycle** (Continued by TestSite_Sweden_2PersonA
Primary End User	Elderly resident in the building			
Secondary End User	Relatives and organization supporting the residential home			
Additional Comments	The robot was installed in Töre in March 2011. This was the first testsite in a larger living facility in Sweden and therefore, a decision was made to include an early installation of the Giraff robot to allow a longer familiarization to the robot. This was particularly necessary in order to ensure that the robot would be exposed to the tenants. An information trip was made to Töre in August 2011 in which the project was. Töre is physically located far from Örebro and while this was a driving motivation to use this testsite as it justified the placement of the Giraff, technical problems which arose were difficult to support. Töre is also the first testsite in which the Giraff could be used to transverse very large space – as the living complex is very large and contains a number of interlinked buildings each with individual apartments.			

TestSite_Sweden_2PersonA

Type	Start Date	End Date	Location	Status
Elder living at the residential home (test site 2)	March 2012	June 2012	Töre (rural area North of Sweden)	**Partial Evaluation Cycle**
Primary End User	Elder resident in the building			
Secondary End User	Relatives			
Additional Comments	During the Grand opening of test site 2, a television channel was filming. At tv we could see the woman expressing interest in using the Giraff to keep in touch with her daughter with family who lives in Johannesburg, South Africa. The woman has fiber in her apartment and wanted to be able to use the Giraff also			

within her home. Due to the fact that the test site was at distance, a pre-configured router to which the Giraff should be able to automatically connect was sent to the woman. The woman already had another router that was used to provide the woman with internet and television services. The router would be connected to this router through an rj45 cable. A decision was taken to end also this test site in June 2012.	

TestSite_Sweden_3				
Type	**Start Date**	**End Date**	**Location**	**Status**
Rehabilitation center	December 2011	October 2013	city, Örebro Sweden	**Partial Evaluation Cycle**
Primary End User	People in need of rehabilitation after e.g. strokes visit the rehabilitation center regularly (1-2 times per week). Description individually follows below.			
Secondary End User	Occupational therapist connects to the Giraff and interacts with the elderly.			
Additional Comments	This testsite is in the same locality as testsite 1b, but with new user group. Interaction takes place during coffee breaks as well as during actual training. Each newcomer to the group coming to the rehabilitation center on Wednesday have been asked to participate in the ExCITE long term study and fill out questionnaires in the longterm plan of ExCITE regularly. The rehabilitation center moved temporarily between locations from February – June 2012 due to reconstruction work. Person a: The woman started in the Wednesday group on Feb 29th 2012 and was introduced to the Giraff and ExCITE. She was then asked to participate with long-term feedback in the project by filling in questionnaires regularly. Person b: The man started in the Wednesday group on Feb 29th 2012 and was introduced to the Giraff and ExCITE. He was then asked to participate with long-term feedback in the project by filling in questionnaires regularly. After two weeks the man says he has been discussing having a Giraff at home with his wife and requests a meeting about this. Preparation for a test site 5 begins. Person c: The man started on April 18. Person d: The woman started on May 9. More persons have started in the group but we estimate that they cannot answer the questionnaires. We inform all persons starting in the group about the Giraff and the ExCITE project. If we believed that the person could answer questionnaires we asked the person to do that. The people connecting to the robot write a comment for every time they connect to the robot and put it in a log.			

TestSite_Sweden_4				
Type	**Start Date**	**End Date**	**Location**	**Status**
Private residence	January 2012	October 2013	city, Örebro Sweden	**Full Evaluation Cycle**
Primary End User	Elder woman who lives in her own residence who wishes to compare Skype and Giraff (with the extra mobility) with her family.			
Secondary End User	Two of the woman's sons with families, one of which lives in the Republic of Fiji (Pilot A) and one (Pilot B) who lives outside Örebro. The woman's brother (Pilot C) who lives about 150 km from her is also a secondary end user.			

Additional Comments	The main previous means of interaction between the primary and two of the end users (Fiji and brother) is Skype. The son outside Orebro sees the woman every week but they are interested in testing the Giraff for communication as well. All users fill out questionnaires regularly following the long term plan of ExCITE (see Section 2.1).

TestSite_Sweden_5

Type	Start Date	End Date	Location	Status
Private residence	Initial contacts March 2012, Deployment April 2012	June 2013	city, Örebro Sweden	**Partial Evaluation Cycle**
Primary End User	A man who has had a stroke that lives with his wife.			
Secondary End User	Son and grandchild in Portugal. Alarm operators from Tunstall (See Test site 1). Other possible users are occupational therapists, formal caregivers, wife.			
Additional Comments	The person is the same as Testsite 3 (Person b). The man uses a stroller and is lame on the right half of the body after the stroke. The wife is worried about that he sometimes loses the balance and falls over the stroller. The wife feels that this could assure her that her husband is safe if she goes away on shorter trips or to their summer holiday house. They wish that they could also use the Giraff in their summer house or at least that the wife could connect to it when she is there, however as they only have mobile internet available there, the ExCITE team cannot promise this. Contacts were immediately taken to prepare Tunstall and the issue of falling was brought up with them. Late April 2012, 38 alarm operators took a training course in driving the Giraff after which they were asked to fill an adopted S0 questionnaire.			

TestSite_Sweden_6

Type	Start Date	End Date	Location	Status
Private residence	October 2012	March 2013	city, Örebro Sweden	**Partial Evaluation Cycle**
Primary End User	Widow (female). Two daughters in the area of Örebro. Sister nearby. Cats.			
Secondary End User	daughters , grandchildren, Two team members, Alarm Center and occupational therapists.			
Additional Comments	The woman was positive to the Giraff but felt that people did not want to connect to her. She had not been disturbed by having the Giraff (which was of the newer hardware) in her bedroom. However she had been afraid of running in to the Wi-Fi usb stick. She also felt that her cats had not reacted to the robot when it was in use. However she suggested that it would be good if she could have hidden the robot away in a "garage". An issue for the woman, similar to for testsite 5, was that the batteries drained out in the remote. Therefore she could not manage to answer the calls if she was not in the bedroom when the Giraff rang..			

TestSite_Sweden_7

Type	Start Date	End Date	Location	Status

Private residence	March 2013	October 2013	city, Örebro Sweden	**Full Evaluation Cycle**
Primary End User	A man, Widower with a Large social network			
Secondary End User	Four friends and son in law			
Additional Comments	During the period on the daycare center he came in contact with the Giraff (testsite3) and his interest awoke to possibly be able to have one yourself. Upon information and viewing of the giraffe, it becomes certain that he became test site 7. The Giraff and the router are placed in the living room. A friend and health care professionals try to call Bertil on several occasions but he does not answer because he did not hear the ring. He moves the Giraff to the workroom closer kitchen where B. is much of their waking hours. Since there sometimes was a problem with finding the way back to the docking station we have attached a big arrow on the wall which is pointing out the docking station. We also have been available when three of the pilots have been driving the Giraff for the first time and in that way given driving lessons on spot. The driving lessons and their first introduction on spot is a way to ease the further use of Giraff and give a more positive impression of communication via Giraff.			

3.3 Test Sites in Spain

In Spain, 4 testsites have been deployed. One common factor is that the Spanish testsites have predominantly secondary users that are family members but in two cases there are also health professionals interacting with the users (Figure 5). Those testsites where family members were involved usually had family members that were located in relatively close proximity to the primary user.

Figure 5 Summary of test sites deployed in Spain

In Spain, fewer but longer running testsites were used in the project. A total of 3 testsites underwent the full evaluation cycle. The testsite, which did not complete a full evaluation cycle, was a relatively short testsite where the poor health of the end users was a key factor.

TestSite_ Spain_1				
Type	**Start Date**	**End Date**	**Location**	**Status**
Private residence	May, 2011	August 2013	Málaga, Spain	**Full Evaluation Cycle**
Primary End User	A widow woman around 65 years old living with one of her sons, but spending a lot of time alone. She tries to be occupied but she is lacking of personal relations: she only meets the relatives from time to time. All of the communication with them are made through phone calls given she is not a technological user, and thus, does not use computers, nor is familiarized with videoconference, although ADSL connection is present in the site. The main need of this person is to be connected to some of their relatives in a more personal manner than a mere phone call.			
Secondary End User	Relatives, one daughter living in a town more than an hour from Malaga, a son in the same city (Malaga), and a nephew living in France. A first impression test about the performance and mobility aspects of the Giraff platform were conducted at UMA considering ten people with a high technological profile. The average age is 28 years (from 24 to 35 years) of both sexes.			
Additional Comments				

TestSite_ Spain_2				
Type	**Start Date**		**Location**	**Status**
Private residence	November, 2011	March 2013	Estepona (Málaga), Spain	**Full Evaluation Cycle**
Primary End User	A widow man of 80 years old who lives alone at home. He is self-sufficient but needs on-site attention, by means of interviews, in order to check the evolution of their mental abilities, as well as routine medical attention, like revising the medication, monitoring the blood pressure, temperature, blood sugar level, etc.			
Secondary End User	Relatives, health center in Estepona (Málaga)			
Additional Comments	The second Spanish test site is managed by a professional team of a health center in Estepona (Málaga), within the public Health Andalucian Service ("Distrito Sanitario Costa del Sol - Servicio Andaluz de Salud". Since this Health Center is at a very touristic area in the Costa del Sol, other potential users of Giraff at this test site may include foreign residents in Spain with relatives living in other European countries. Thus, apart from the local assistance carried out by nurses or caregivers, an additional benefit to evaluate is how Giraff can improve or facilitate social and family relationships.			

TestSite_ Spain_3				
Type	**Start Date**	**End Date**	**Location**	**Status**
Private residence	January, 2012	March 2013	Coín (Málaga), Spain	**Full Evaluation Cycle**
Primary End User	A widow woman of 77 years old living alone at her house. Since she is in a wheelchair, she is not self-sufficient and needs a caregiver at home, who does the daily chores and assists her. She is glad to participate in the ExCITE project and hopes to be in a closer contact with her relatives through the Giraff, especially with her grandchildren, who live in other cities of Andalucía. An internet connection with a wifi signal provided by a router was available, though the elderly woman has not notions about computers and new technologies.			
Secondary End User	Relatives and friends			
Additional Comments				

TestSite_ Spain_4				
Type	**Start Date**	**End Date**	**Location**	**Status**
Private residence	March 2012	August 2012	Estepona (Málaga), Spain	**Partial Evaluation Cycle**
Primary End User	An English couple who lives in the Costa del Sol. He is a former pilot, now retired, of about 75 years old. Although both of them are self-sufficient they have some heath issues that require periodic monitoring and checking. They are also willing to have the Giraff to establish more frequent and friendly connections to some friends and relative in UK.			
Secondary End User	Relatives, professionals from the health center in Estepona (Málaga)			
Additional Comments	This test site is also managed by a professional team of a health center in Estepona (Málaga), within the public Health Andalucian Service ("Distrito Sanitario Costa del Sol - Servicio Andaluz de Salud" given the health problems of the primary user. Serious health problems of this primary user together with limitations of the internet connection in the health center have significantly reduced the number of connections in this test site. For this reason, the test site was ended.			

3.4 Test Sites in Italy

In Italy, a total of 8 testsites have been deployed. One common factor is that the Italian testsites have predominantly secondary users that are family members. This phenomenon is a reflection today of how care is usually administered and the responsibility of care is often on the individual level. Those testsites where family members were involved usually had family members that were located in relatively close proximity to the primary user.
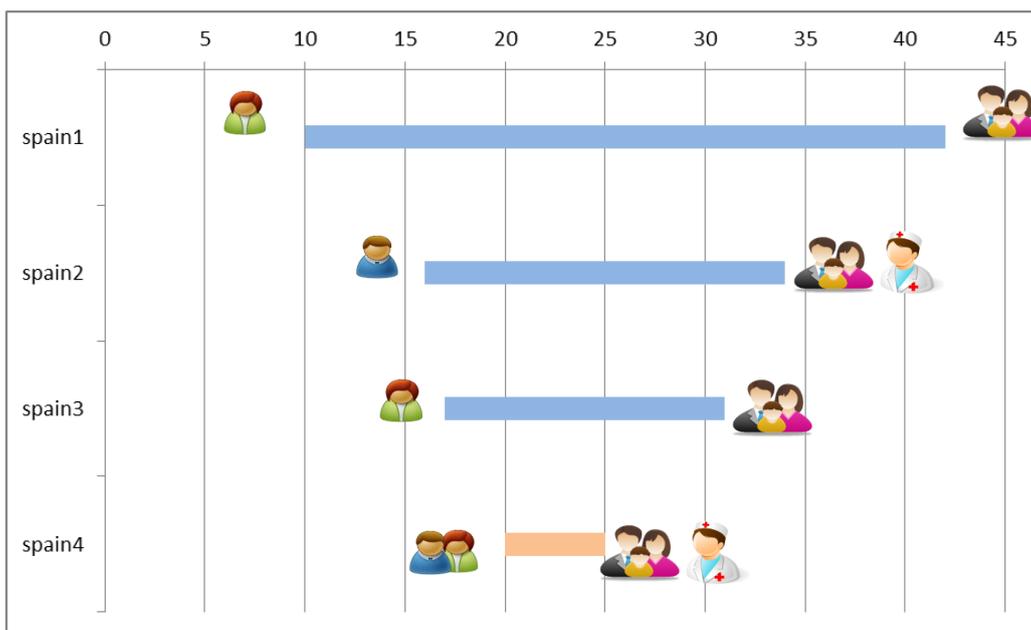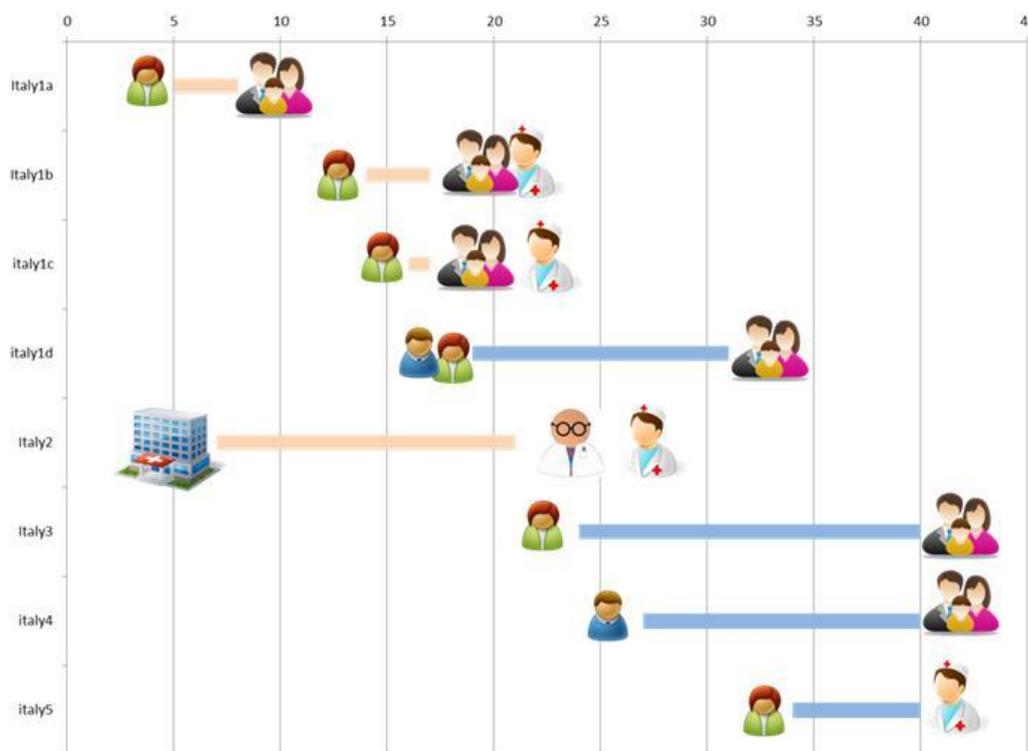
Figure 6 Summary of test sites deployed in Italy

In the beginning of the project, it was noticed that there were many concerns from the Italian user groups about the technology and possible negative effects of it. For this reason, the first testsites in Italy were short. In fact, this result is in line with other previous cross-cultural studies about robots in the home, namely [Cortellessa et.al 2008]. Another factor which affected some testsites is related to the communication infrastructure and its stability, as the project progressed and newer versions of the Giraff solution offered alternative communication solutions, more testsites could remain stable and long running. In Italy, 4 testsites completed the full evaluation cycle and one of them followed a different plan since it was related to the use of Giraff as a means to provide cognitive rehabilitation to people with Mild Cognitive Impairment (see Section 7 - Italy Test site 2).

TestSite_ Italy _1(a)				
Type	**Start Date**	**End Date**	**Location**	**Status**
Private Residence	Initial contacts in October 2010	December 2010	Rome	**Partial Evaluation Cycle** (replaced by TestSite_Italy_1(b))
Primary End User	The first attempt of a test site in Italy was that of a private home of a woman with a reduced mobility capability, who lives with a caregiver and spends much of her time at home receiving weekly visits from her daughter who lives in the same city. The woman has two other sons who live far away and Giraff could have offered the possibility of increasing the frequency of contact with them. In this first case, we experienced many problems with Internet connection at the old woman apartment that prevented a robust use of the robot. These initial problems discouraged the old woman and contributed to reduce her interest toward the experimentation. Additionally she had health problems			

	and she decided to end her participation in the experimentation
Secondary End User	Relatives, especially her daughter
Additional Comments	The test site ended due to participant's mild ischemia, which occurred in December 2010.

TestSite_ Italy _1(b)				
Type	**Start Date**	**End Date**	**Location**	**Status**
Private Residence	Initial contacts in July 2011	September 2011	Rome	**Partial Evaluation Cycle** (replaced by TestSite_Italy_1(c))
Primary End User	This woman lives alone in an apartment and is in contact with her relatives and friends as well as an operator from a Charity organization Comunità di Sant'Egidio and her daughter and nephew.			
Secondary End User	An operator form the charity organization and his son			
Additional Comments	There is a cultural aspect connected to the Italian case that seems to discourage the use of such a technology. Privacy issues have been raised, connected to the internet connection use. Privacy issue; psychological fears were the main reasons for ending the test sites			

TestSite_ Italy _1(c)				
Type	**Start Date**	**End Date**	**Location**	**Status**
Private Residence	Initial contacts in October 2011	November 2011	Rome	**Partial Evaluation Cycle** (replaced by TestSite_Italy_1(d))
Primary End User	This woman lives alone in an apartment and is in contact with her relatives and friends as well as an operator from a Charity organization Comunità di Sant'Egidio and her daughter and nephew.			
Secondary End User	an operator form the charity organization and her daughter and nephew			
Additional Comments	Participant's illness and hospitalization were the reason for ending the test site			

TestSite_ Italy _1(d)				
Type	**Start Date**	**End Date**	**Location**	**Status**
Private Residence	January 2012	January 2013	Grottaferrata (20Km from Rome)	**Full Evaluation Cycle**
Primary End User	A couple of old people living in the countryside near Rome. The man has reduced mobility, while the woman has problems with her sight. They are quite independent although their health condition is slowly deteriorating. Their son lives in Rome and visits them on a regular basis (usually once a week).			
Secondary End User	The son living in Rome city centre (very busy person who uses computer for work) and their nephew (skilled videogamer)			

Additional Comments	

TestSite_ Italy _2

Type	Start Date	End Date	Location	Status
Health care organization	Initial contacts in January 2011	January 2012	Rome	**Full evaluation Cycle** The evaluation plan was designed on purpose (see Section 7)
Primary End User	The aim of this test site is to investigate the use of Giraff as a tool for rehabilitation of Mild Cognitive Impaired patients. The robot is under test at the center since the beginning of 2011. In collaboration with the center a protocol has been set up to first assess the emotional response of a sample of elderly people with mild cognitive impairment in terms of stress and anxiety to the Giraff physical presence. End users are 17 older adults.			
Secondary End User	A therapist at Istituto Don Gnocchi.			
Additional Comments	It is worth highlighting how the use of Giraff in a context different from a private residence and also involving fragile people has entailed the need to introduce a preliminary evaluation phase to understand the emotional reaction of this people to the interaction with a therapist trough Giraff. This also entailed a specific effort to obtain the Ethical Approval of the study.			

TestSite_ Italy _3

Type	Start Date	End Date	Location	Status
Private Residence	May 2012	November 2013	Rome	**Full Evaluation Cycle**
Primary End User	A very active 74 years old woman living alone in Rome is the end user of this test site. The woman suffers from depression and feels often alone. She likes the idea to use Giraff as a way of increasing her social communication with the external world.			
Secondary End User	Her grandchild and daughter are the main current secondary users. Additionally we have also recently involved day care center that provides weekly connection to the woman. The center usually provide daily social support to elderly and people in need.			
Additional Comments	Initial problems with the internet connection delayed a bit the achievement of the steady state of this test site. The problem are now solved apart some sporadic events due mainly to the internet service robustness in Italy.			

TestSite_ Italy _4

Type	Start Date	End Date	Location	Status
Private Residence	May 2012	December 2013	Rome	**Full Evaluation Cycle**

Primary End User	Male. The older user is affected by Parkinson's disease since 2005. Both his walking ability and the speech were deeply compromised by the severe stiffness in movement as well as the muscle rigidity of the face. In particular, due to the speech restriction, the user often refuses the communication with the others and prefers to stay alone.
Secondary End User	The Client is the son of the older user. He lives with his family 30 Km away from the town of the user.
Additional Comments	When he was living with his father and mother, he was the main user of technologies at home, so he explained to the user how to upload a new software program, for example, or how to play on line games. Also now, he is the person who they contact in case of need, for supporting them with the technologies.

TestSite_ Italy _5				
Type	**Start Date**	**End Date**	**Location**	**Status**
Private Residence	May 2013	December 2013	Rome	**Full Evaluation Cycle**
Primary End User	72 years older woman, with primary education. The end user has own home in Rome in which she has a self supporting life. Her apartment is on the first floor of a condominium and it is organized on a single level.			
Secondary End User	Two social assistance workers are the pilots of this case study. Both clients working at a day care center for frail elderly run by the aforementioned social and assistance services cooperative. Prior to enrollment in the case study, the two pilots have never met the end user. A first meeting between all users of the case study was organized at the senior center in order to check the availability of end user to accept a service of social support at a distance throourgh the telepresence system.			
Additional Comments	Once a week the end user benefits of home help service for some daily life tasks. In addition, she attends the neighborhood's senior center. During the time at the senior center, end user's principal activity is related to the care of the garden and to the assistance to the most needy users.			

4   SWEDEN Test Sites Results

In this section we provide a summary of the main results gathered from each test site in Sweden. Specifically we report the feedback obtained from all the Swedish test sites for which it was possible to follow the evaluation methodology described in the Section 2. In Section 7, we then introduce the work on all other test sites.

*For each test site we distinguish between the **end user side**, that is the old user having the robot at home and the **pilot side**, that is the secondary user connecting to the house of the older user through Giraff. The results are presented for each test site according to this subdivision.*

4.1 Test site Sweden 4

The entire long-term experience lasted almost two years, from January 2012 – November 2013.

4.1.1 Participants

End User: The older woman is 72 when the Giraff robot is deployed. She is a healthy woman with a rich social network and does not require any assistance services. The woman has a long experience (>10 years) of using Skype to communicate with her son who has lived in other countries for a long time. She is highly motivated to participate in the project and believes that being able to interact while moving around will make a better interaction, particularly with the grand-child.

Pilot User: Originally, there are three interested pilot users; a brother, a son with family living nearby who the elder woman meets every week and a son living on Fiji with his family. The son has no expectations other than that using Giraff may be a complement to their standard way of interacting, Skype.

4.1.2 End User side

4.1.2.1 Psychological measures

Over time, the results of Geriatric Depression Scale (GDS), Perceived Loneliness Scale (UCLA) and Short Form-12 Health Survey (SF-12) show scores substantially similar and indicative of satisfactory physical and mental health status. The end-user experience indicates neither depression symptoms (score between 0-5) nor loneliness (score < 15) and in general the woman has an adequate perceived health status (PCS and MCS scores >20).

1.1.1.1 Robot Acceptance

In general, the mean scores of each Almere Model construct shows a moderate acceptance of Giraff between the steps of evaluation plan (Figure 7).

The levels of Perceived Ease of Use (PEOU), Perceived Adaptiveness (PAD), Perceived Usefulness (PU) and Perceived Enjoyment (PENJ) remain moderately uncertain; the end user is doubtful in judging the ease of use and usefulness of the robot, the concrete ability of the robotic system to adapt to the everyday life needs and the pleasantness of the feelings of joy associated with the use of the robot.
Over time, Attitude (ATT) and Facilitating Conditions (FC) are constant and high. She has positive feelings about the appliance of the robot and she perceives factors in the environment that facilitate use of the telepresence system.

Initially, the end user is hesitant about the integrity and reliability of the robot, but the TRUST increase at time S2 and S3 showing a more firm belief.

The Intention to Use (ITU) the system, over a longer period in time, is rather high at time S0 but it slightly decreases in following steps of the evaluation.

Referring to Social Influence (SI), at time S0 the end user does not perceive that people who are important to her think she should or should not use the robot (SI). At time S3 she shows hesitation with respect to this aspect.

No anxious reactions (ANX) when it comes to using the robot over time.
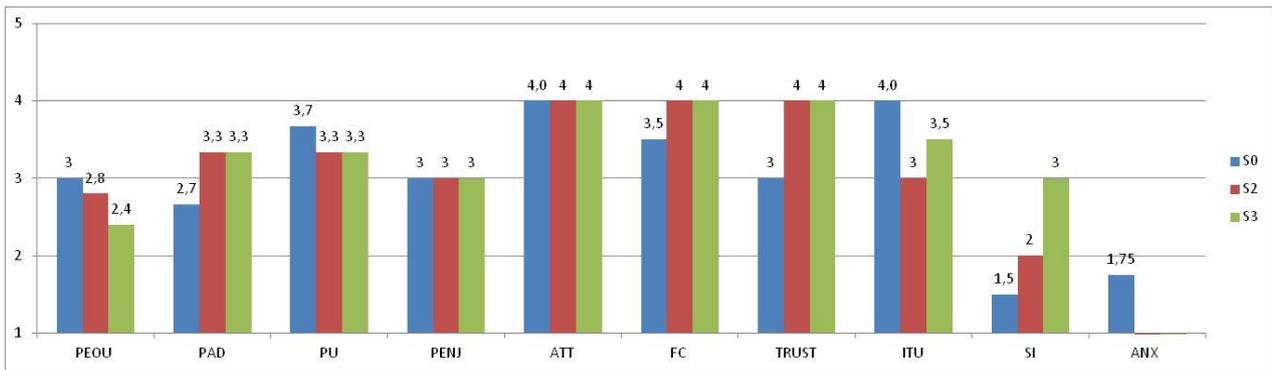
Figure 7: Mean scores for each Almere Model constructs
(5 points Likert scale, from 1= completely disagree to 5= completely agree)

4.1.2.2 Attitude and affective response toward the robot

During the first period of usage (Figure 8), the end user does not perceive the robot as an intrusion into her privacy (M=1.67) and recognizes the benefits and advantages (M=3.79) of the system related to her needs. She shows a good level of satisfaction toward the Giraff's functionalities and features (M=2.67) and does not perceived a psychological distance between her and the robot (M=1). No apprehension related to the difficulty of maintenance of the robotic device (M=1) emerged.
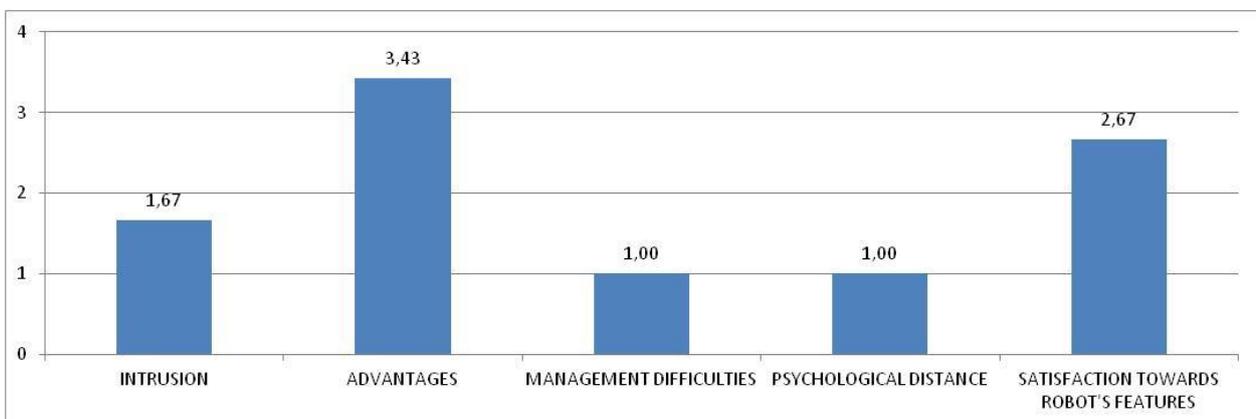
Figure 8: Mean scores for each dimension
(5 points Likert scale, from 0= completely disagree to 4= completely agree)

In addition, Positive affect subscale of PANAS shows higher score (39) than Negative Affect subscale (10) and this result indicates that the end-user experienced a pleasurable engagement with the robot that can be seen as fun, interesting, useful and stimulating.

4.1.2.3 Telepresence dimensions

The analysis of the distribution of responses related to an hoc questionnaires adapted based on the *Temple Presence Inventory* and the *Networked Minds Social Presence Inventory* (Figure 9) shows that the end user perceived a high level of **Social Richness** (in terms of subjective experience of warmth and intimacy in the mediated Interaction), **Social Presence** (in terms of the feeling of being together), **Co-presence** (in terms of psychological connection to and with another person) and **Perceived Enjoyment** (degree of being enjoyable during the technology usage).
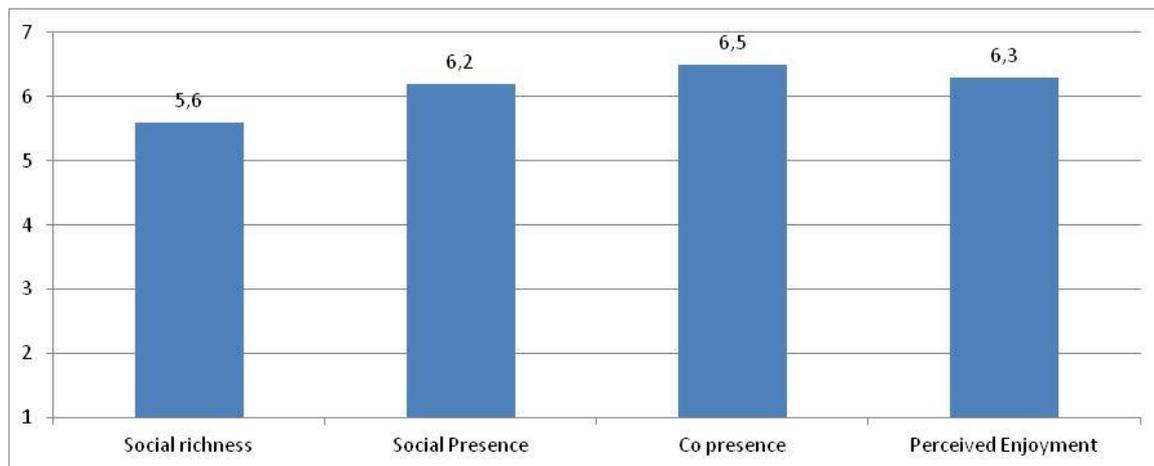
Figure 9: Mean scores for each telepresence dimension
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

4.1.2.4 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

The PIADS subscale scores show that the use of the robot has affected different important aspects of the end user's quality of life involving an improvement in terms of **Self-Esteem** (M=1.75), reflecting self-confidence and emotional well-being. Particularly, the adoption of Giraff had a positive impact in terms of decreased Embarrassment (feeling awkward) and of a lower Frustration (being upset about lack of progress in achieving own desire). In addition, the mean score of **Competence** (M=1.67) indicate a positive impact in terms of perceived functional capability, independence and performance.

Overall, analyzing the distribution of responses to the items of the two subscales, the use of Giraff has a strong positive impact on the following aspects:
- Sense of being able to do what you want in own environment (Sense of Control)
- Feeling that you have a significant influence over own life (Sense of Power)
- Satisfaction with life (Happiness)
- Felling safe (Security)
- Trust in own abilities (Self Confidence)

- Feeling able to cope (Capability)
- Feeling able to perform task well (Skillfulness)
- Knowledge in a particular area (Expertise)
- Feeling of effective management of day to day tasks (Efficiency)
- Feeling able to handling life situation (Adequacy)
- Feeling not needing help from someone or something (Independence)

The average score on **Adaptability** subscale (M=1.17) is indicative of a lighter impact of Giraff in terms of willingness to try new experiences and feeling of well-being perceived in relation to the use of robot. In particular, aspect like the ability to join in activities with other people (Ability to Participate) and feeling open to new experience (Eagerness to try new things) improve related to the use of the robot.
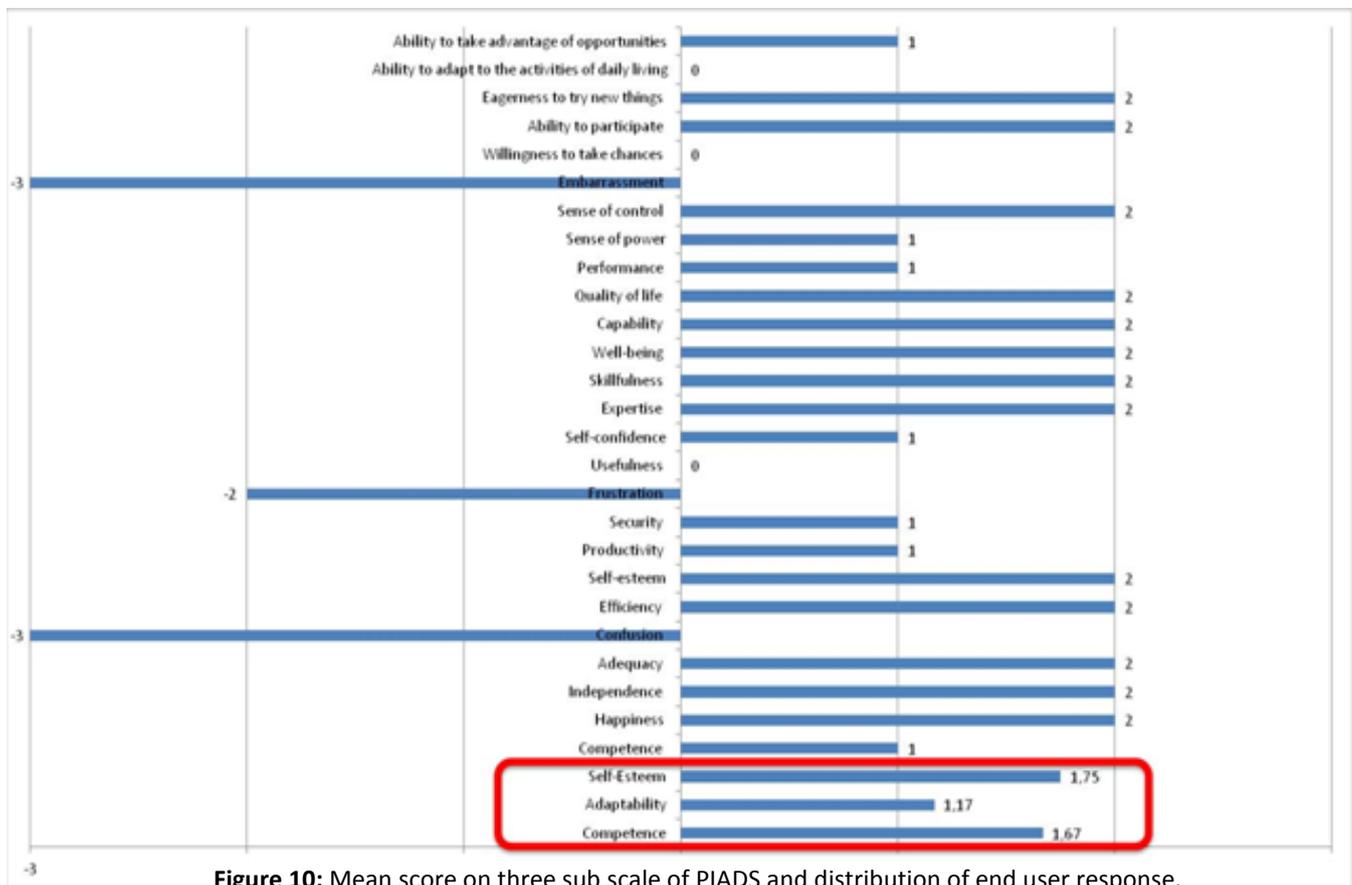
Figure 10: Mean score on three sub scale of PIADS and distribution of end user response. Scale from -3 [Decreases] to + 3 [Increases]

4.1.3 Pilot side

4.1.3.1 Expectations toward the telepresence system

The client's expectations related to the use of the telepresence system as a communication aid with his relative are generally confirmed over time (Figure 11)

Specifically, the client does not believe that a telepresence robot may be a threat to the privacy of the older end user. At time S0, the client assumes that the interaction mediated through the robot may be a very easy way of interacting for the older user. The use experience modify this initial expectation at time S2, when the client believes that the interaction mediated through the robot is moderately easy for the end user.

The client imagines that Giraff could be a lot of support for his caregiving role and a good element of reassurance for him at distance. The usage of the telepresence system is also evaluated as a very good means to alleviate the need of client's presence at his relative's home.

In addition, the telepresence system may provide more stable and frequent contacts between the client user and the end users. The user does not believe that the use of the system may have an adverse effect on their relationship nor on the opportunities for physically visits. The Giraff telepresence system is recognized as a means to alleviate the end users' reliance on the client and to handle unexpected events.

These expectations are confirmed during the user experience between S0 and S2, expect for the issue above-mentioned relative to ease of interaction for the end user.

At S4, after the conclusion of the case study, the expectations expressed at S0 and at S2 are not confirmed. According to the questionnaire, the client user, who has used Giraff instead of Skype to interact with his mother does not seem to perceive a particular impact due to the removal of the system. The end user's interaction with the client remains moderately easy even in the absence of the Giraff system. It is likely that the habituation to Skype has some impact on this.
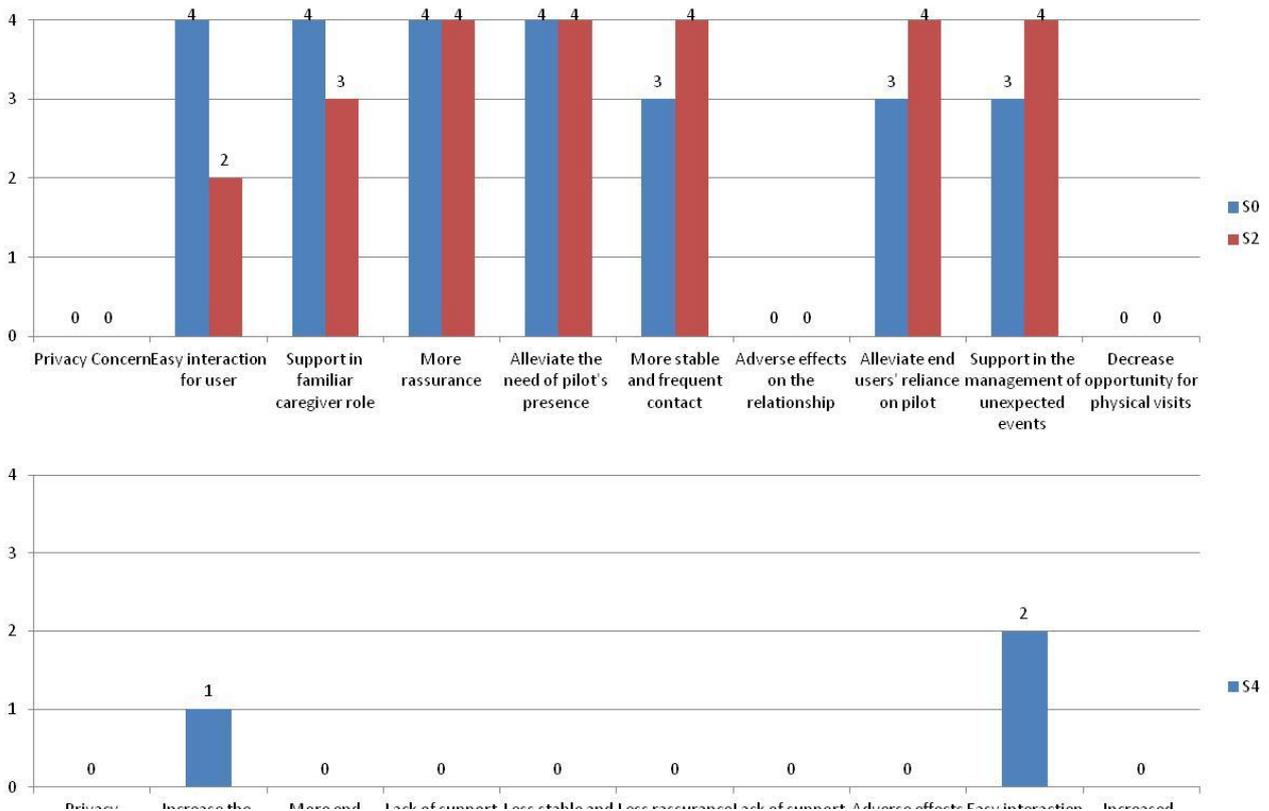
Figure 11: Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system
(5 point Likert scale from 0=not at all to 4=very much)

4.1.3.2 System Usability Scale - Ease/Difficulty of learning and use functions and commands interface

The analysis of the System Usability Scale (SUS) questionnaire showed a score of 85 indicating a high level of subjective usability of the Giraff's client interface. This result is also confirmed by the questionnaire on the usability of the system we developed ad hoc, which shows scores sufficiently high over time (see Figure 12). However some aspects of the usage become worse over time. Specifically, the usability of "Start Application", "Video quality", "Navigation", "Movement management" and "Safety of movement" become more difficult at S2.

For the remaining aspects, the perceived usability increased or remained constant and satisfactory between S0 and S2. However, it should be noted that the questionnaires S0 and S2 were filled while using Pilot 1.3 and that the client user later tried both Pilot 1.4 and 2.0. He commented on usability aspects during the final interview. He said that the client interface was continuously improved during the time the test site was running, not only did the changes in the interface lead to a perceived easier use of the system but also a higher trust in the system when the design became more similar to other current Windows programs.
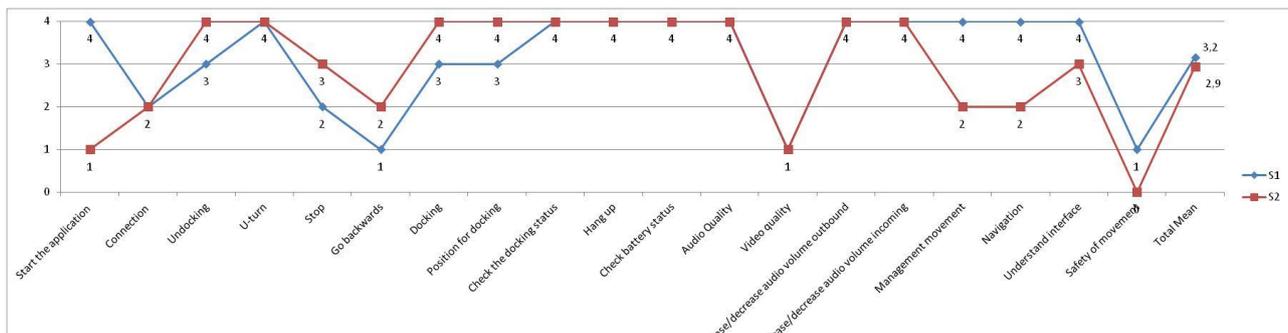
Figure 12: Questionnaire distribution on pilot response to usability assessment
(5 points Likert scale from 0 = very difficult, 4 = very easy)

4.1.3.3 Telepresence dimensions

Regarding the telepresence dimensions of *Temple Presence* and *Networked Minds Social Presence Inventory* (see Figure 13), the secondary user shows a high degree of perception of **Perceived behavioral interdependence** (extent to which a user's behavior affects and is affected by the other's behavior), **Perceived psychological engagement** (extent to which the user feels mentally immersed in the experience), **Social richness** (subjective experience of warmth and intimacy in the mediated Interaction), **Social Presence** (feeling of being together), **Perceptual Realism** (experience in which the mediated interaction accurately simulates or reproduces the sensory experience that would be expected in the non-mediated interaction).

Degrees of perception are less satisfactory in the categories of **Spatial presence** (sense of being physically located in a virtual environment) and **Co-presence** (psychological connection to and with another person).
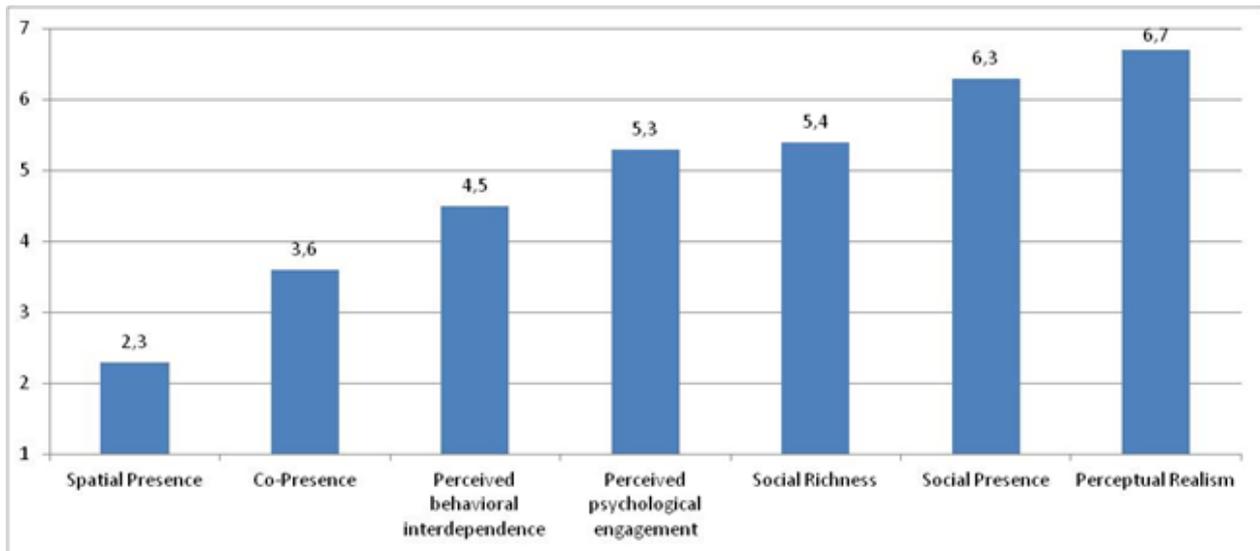
Figure 13: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

4.1.3.4 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

Analysis on the PIADS scale reveals that the use of Giraff system has had a positive psychosocial impact on the secondary user's life (Figure 14) overall. From the point of view of the three sub-scales of the PIADS, it is possible to say that the main improvement has been obtained especially with respect to Adaptability (M= 1.67), that is willingness to try new experiences and a feeling of well-being perceived in relation to the use of robot. Results show a considerable increase in the ability to participate, eagerness to try new things, ability to adapt to the activities of daily living and in the ability to take advantage of situations.
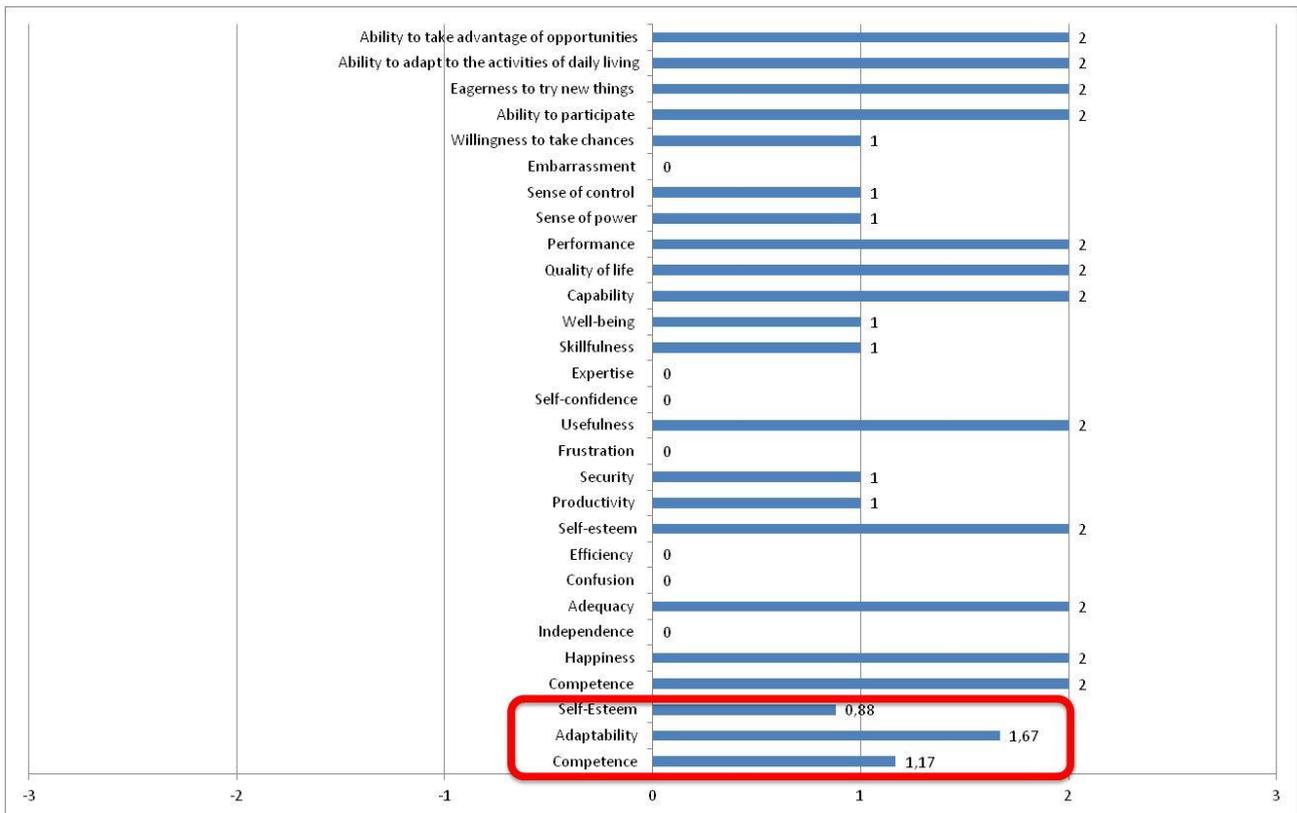
Figure 14: Mean score on three sub scale of PIADS and distribution of end user response.
Scale from -3 [Decreases] to + 3 [Increases]

Additionally, we found a lighter impact of Giraff in terms of Competence (M = 1.17) that is perception of functional capability, independence and performance. Results show that in particular the Giraff system has improved mainly the adequacy, usefulness (feeling to be helpful to oneself and others), capability, quality of life and performance (able to demonstrate own skills). The system does not have an evident impact on Self-esteem (M= 0.88).

4.1.3.5 Affective state related to the use experience and interaction through telepresence system: PANAS scale

4.2 Test site Sweden 7

The entire long-term experience lasted 8 months, from March 2013 – November 2013. A 4G WiFi-router was used to connect the Giraff to the internet.

4.2.1 Participants

End user: The man is 74 years old when the Giraff is deployed. The man is a widower with a large social network from his previous work life and involvement in the Swedish church. He reports to have a sufficient prior computer experience and regularly uses the email feature. The man suffers from cerebral palsy, which is causing weakness in the legs. As a result of this, he has a frazzled

shoulder. He has pain problems that affect his everyday life both physically and mentally. Because of this, he uses a walker for moving indoors and an electrical wheelchair for moving outdoors. The man also has hearing aid. The man carries a security alarm and gets daily help from homecare services. Periodically, the man is depressed.

Pilot user: Originally, there were five people interested in connecting to the Giraff (one son in law and four friends, three of which work in a church and one in Skåne, Sweden). The son in law never connected. The one in Skåne and two of the friends from church tried connecting without success. The one pilot user reported on in the results interacts with the end user in person or via the telephone a few times per month. He succeeded using the Giraff at least occasionally.

4.2.2 End User side

4.2.2.1 Psychological measures

Over time, the results of Geriatric Depression Scale (GDS), and Short Form-12 Health Survey (SF-12) show scores substantially similar and indicative of satisfactory physical and mental health status. The end user experiences neither depression symptoms (score between 0-5) nor loneliness (score < 15) and in general he has an adequate perceived health status (PCS and MCS scores >20).

4.2.2.2 Robot Acceptance

For this end user we have data for time S0 and S3.
In general, the mean scores of each Almere Model constructs show a doubtful acceptance of Giraff robot between the two steps of evaluation plan (see Figure 15).
Questionnaire distribution of end user responses to robot acceptance assessment over time show a clear uncertainty of the end user in judging Perceived Ease of Use (PEOU), Attitude (ATT), Perceived Adaptiveness (PAD), Perceived Usefulness (PU) and TRUST. Except for PEOU that remain constant at S3, the other dimensions decrease showing a tendency to have a unfavorable attitude towards the use of the robot and clear uncertainties about the usefulness, the ability of the robotic system to adapt to the everyday life needs and the integrity and reliability of the robot.
No anxious reactions (ANX) when it comes to using the robot over time.
At time S0, Intention to Use (ITU) and Social Influence (SI) are rather high, but over time these aspects considerably decrease.
Over time, the end user shows a constant strong hesitation towards the Facilitating Conditions (FC) and Perceived Enjoyment (PENJ) related to use of the robot.
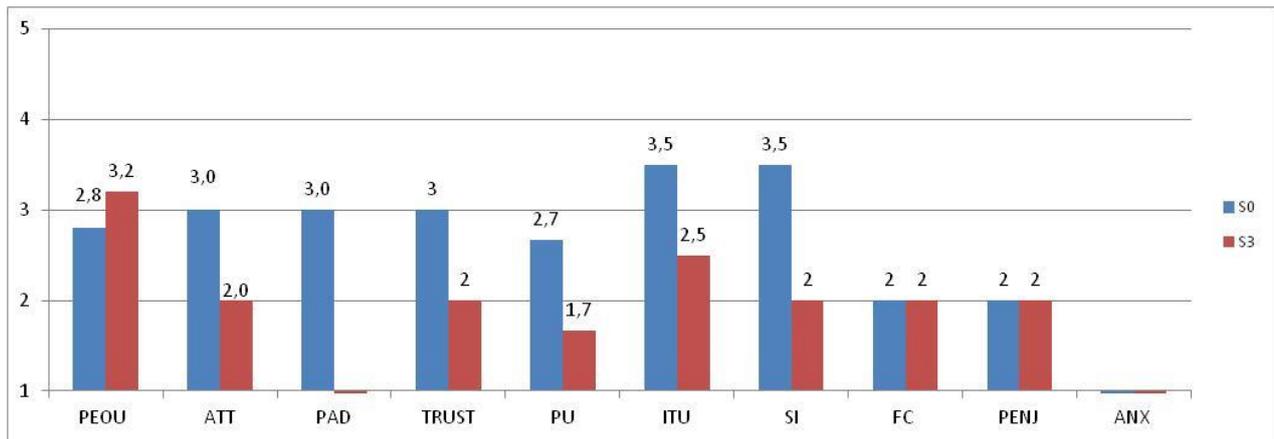
Figure 15: Mean scores for each Almere Model constructs
(5 points Likert scale, from 1= completely disagree to 5= completely agree)

4.2.2.3 Attitude and affective response toward the robot

During the first period of usage (S1; Figure 16), the end user has a moderate perception of the robot as an intrusion into his privacy (M=1.9). He does not recognize the benefits and advantages (M=1.3) of the Giraff related to his needs. In addition, he experiences a psychological distance between himself and the robotic aid (M=2.4). Also, he shows a moderate apprehension for management difficulties (M=1.8). However, the end user shows a decent satisfaction toward the Giraff's functionalities and features (M=2.5).

The end user reported a rather negative affective response toward his experience with the telepresence robot. The PANAS scale shows average values of positive and negative affects (17 vs. 13) that are indicative of a rather unfavorable use experience of the robot perceived as cumbersome, slightly intrusive and barely useful. This is a reflection of the fact that the secondary user only managed to connect to the robot occasionally.
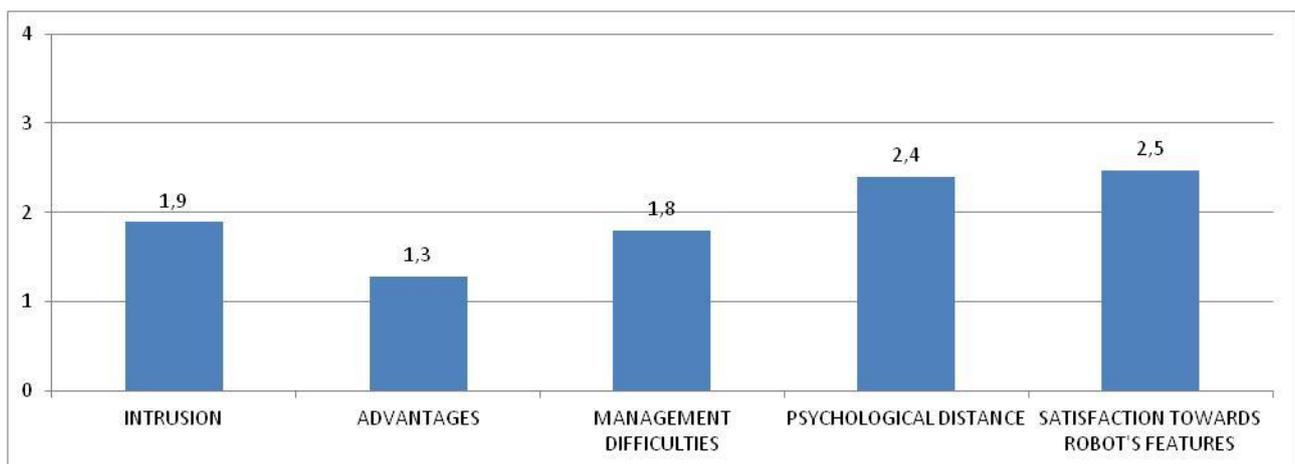
Figure 16: Mean scores for each dimension
(5 points Likert scale, from 0= completely disagree to 4= completely agree)

4.2.2.4 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

Analysis on the PIADS questionnaire reveals that, overall the use of the telepresence robot had not a positive psychosocial impact on the end user's everyday life (Figure 17). Comparing the mean scores of the three subscales of the PIADS, it is possible to note a slight improvement in the **Adaptability** (M=0.33) with a small increase in the ability to take advantages of opportunities and eagerness to try new things. The use of robots has had a negative impact in terms of **Self-esteem** (M=0.38) decreasing feeling of pleasure and increasing frustration related to the use of robot. No remarkable changes in term of **Competence** (M=0.08), even though a decrease of perceived efficiency emerge. It is possible that the response to the PIADS questionnaire is affected by the fact that the Giraff was only used occasionally.

Figure 17: Mean score on three sub scale of PIADS distribution of end user response.
Scale from -3 [Decreases] to + 3 [Increases]

4.2.3 Pilot side

4.2.3.1 Expectations toward the telepresence system

At time S0, Client 7 has high expectations about the ability of the system to be able to offer more stable and frequent contact, to alleviate the need of the client's presence and the end user's reliance on the client. In addition, the client assumes that the interaction mediated through the robot may be a very easy way of interacting for the older user.

Nevertheless, from the client's point of view the telepresence system may offer a moderately higher reassurance at distance. He does not consider the system to be a valid help to support him in his friendly caregiver role and in the management of unexpected events. The telepresence robotic system represents also a potential element of intrusion in the end user's domestic life.

Similarly to the client 4, this client does not seem to perceive a particular impact due to the removal and disuse of the telepresence system. A possible reason is the only occasional use of the robot. In particular, it is important to observe that in the follow up step (S4) the client assumes that the domestic privacy of end user is reestablished and it is easier for him to interact with the client. (Figure 18).
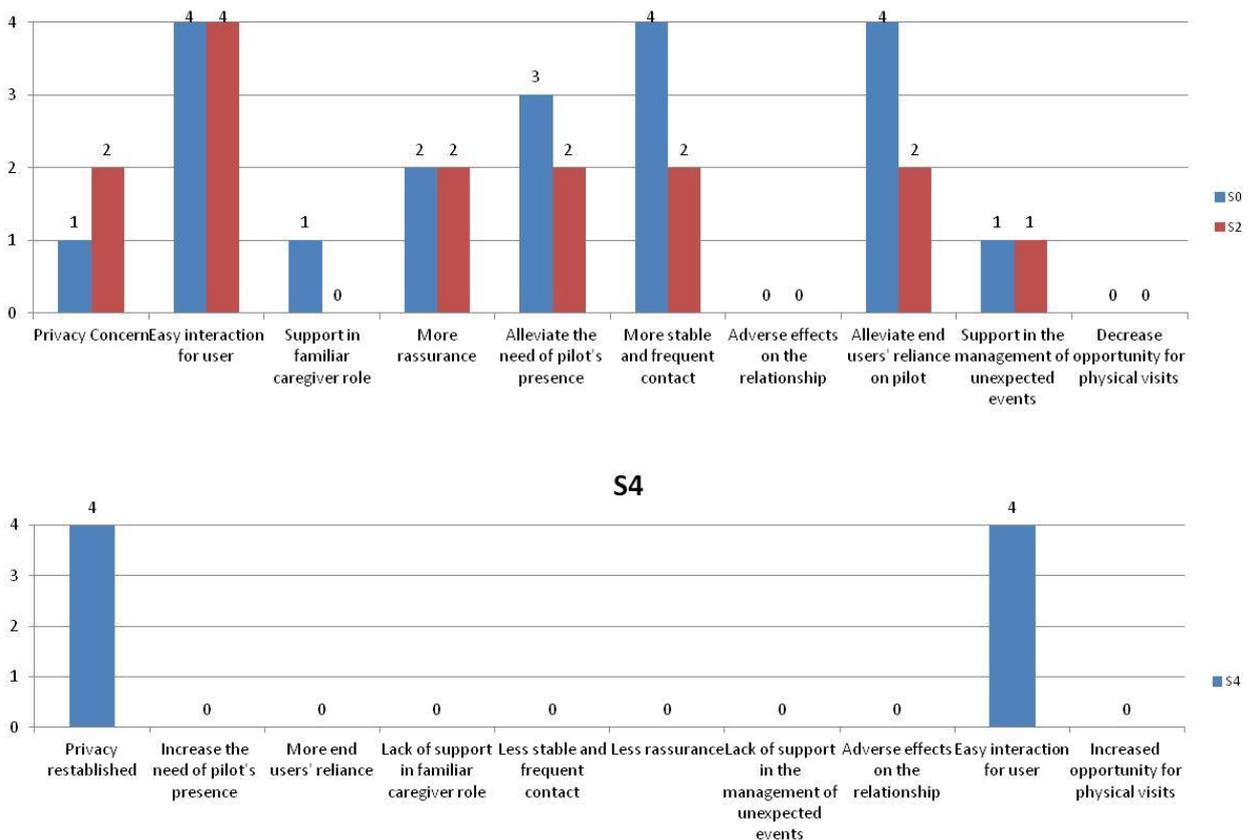
Figure 18: Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system
(5 point Likert scale from 0=not at all to 4=very much)

4.2.3.2 System Usability Scale - Ease/Difficulty of learning and use functions' and commands' interface

The analysis of the SUS questionnaire showed a score of 82.5 indicating a high level of subjective usability of the Giraff's client interface. This result is also confirmed by the questionnaire on the usability of the system developed ad hoc, which shows consistently high scores between S1 and S2 with the exception of functionalities related to docking, battery and audio (Figure 19). These aspects become more difficult at S2.
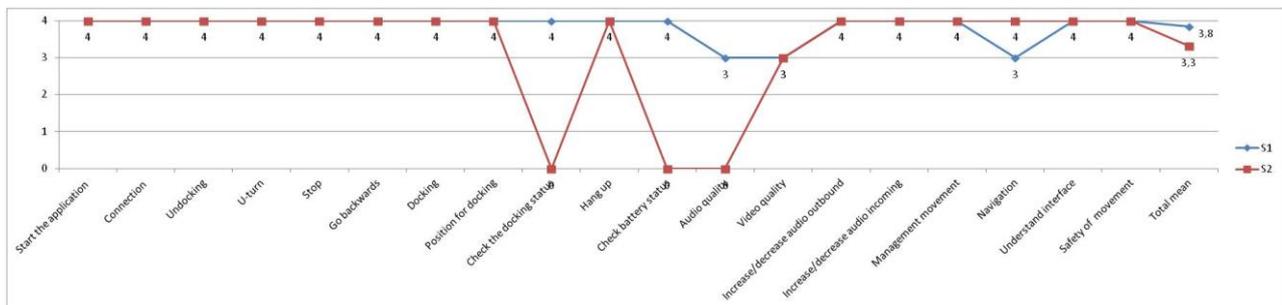
Figure 19: Questionnaire distribution on pilot response to usability assessment
(5 points Likert scale from 0 = very difficult, 4 = very easy)

4.2.3.3 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

The PIADS subscale scores show that the use of telepresence system did not have a remarkable psychosocial impact on secondary user's life (see Figure 20).
The average score on **Competence** (M=0.92), **Adaptability** (M=0.83) and **Self-esteem** (M=0.5) subscales are indicative of a weak impact in terms of improved functional capability, independence, of performance and of willingness to try new experiences and of self-confidence and emotional well-being.
Overall, there are not noteworthy changes indicating an improvement in the secondary user's everyday life following the adoption of the telepresence system.
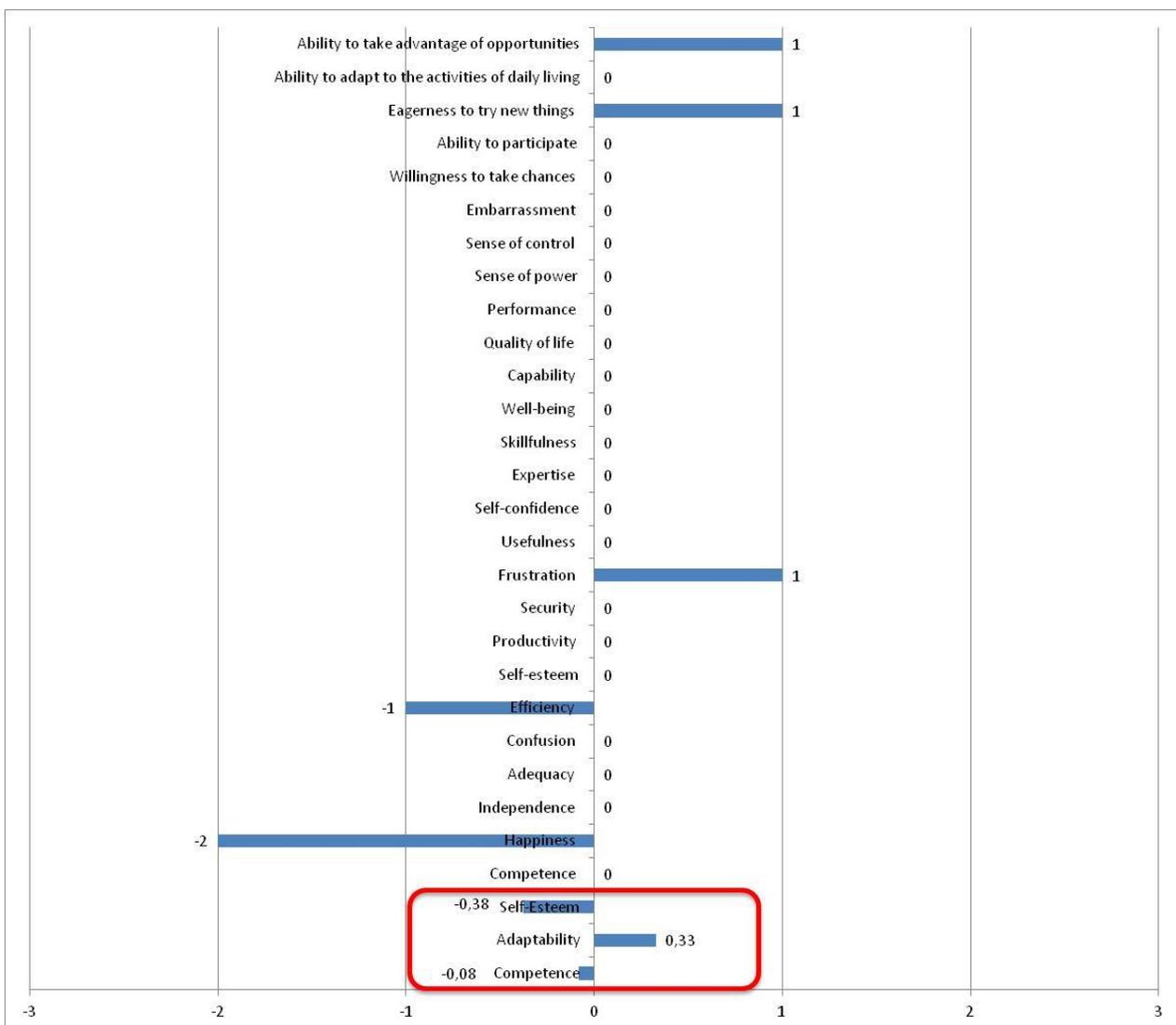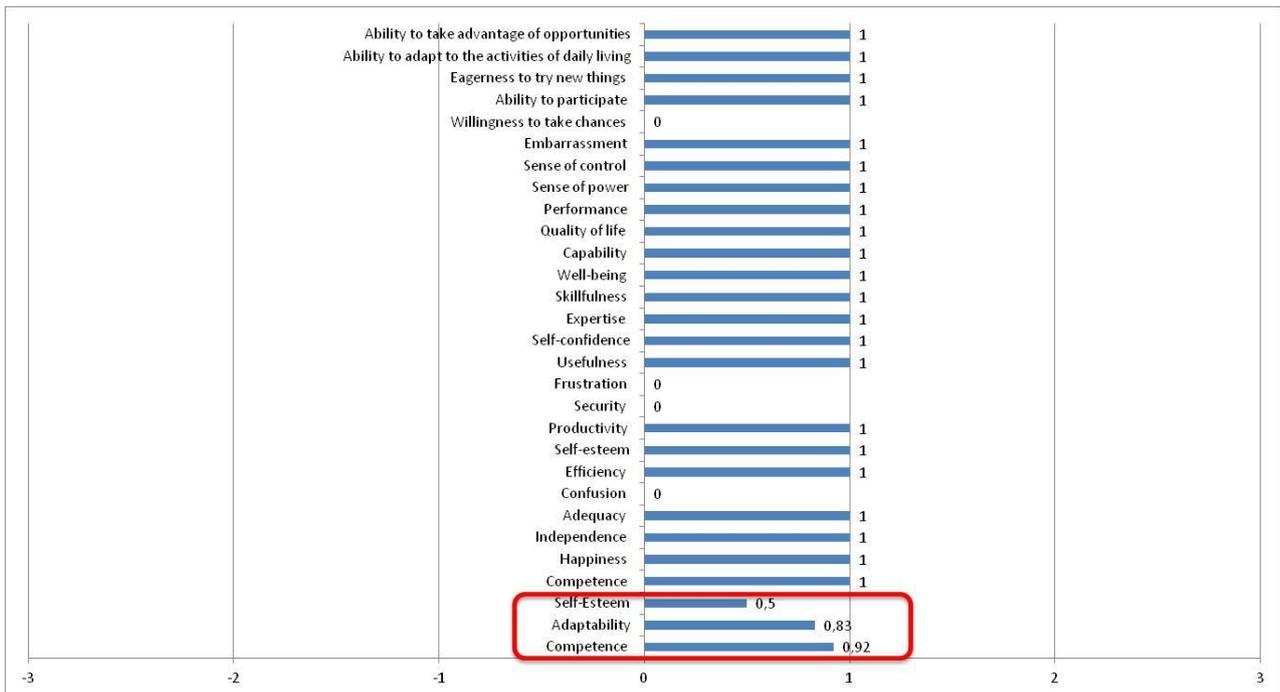
Figure 20: Mean score on three sub scale of PIADS distribution of end user response.
Scale from -3 [Decreases] to + 3 [Increases]

4.2.3.4 Affective state related to the use experience and interaction through telepresence system: PANAS scale

Although the PANAS scale shows an average value of positive affects (21) towards the Giraff telepresence system that is higher than the negative affect scale (10), these results are indicative of a rather unsatisfying use experience of the robot.

4.3   Discussion of Swedish Test Sites

The Swedish test site that completed the Evaluation plan involved 2 older end users (**72yr F** [Test Site 4] and **M 74yr** [Test Site 7]) and 2 clients (4 and 7). The client at Test site 4 belonged to the end user's family network. However, it should be noted here that the client was living at a 12h time difference with respect to the end user. The client at Test Site 7 belonged to the end user's network of friends.
The experience of long-term use of the telepresence system Giraff is different between the two case study reported in this deliverable. These differences are reflected both in the questionnaire data and in the interviews conducted when the test sites were ended. In general, the experience of long-term use has been quite positive for the Test Site 4 in terms of attitude, affective response, robot acceptance, psychosocial impact, usability and dimensions of telepresence. On the contrary, the users of the Test Site 7 showed a critical assessment of the telepresence system Giraff from the point of view of the dimensions investigated.

In the following, we provide an overall interpretation of the results and differences related to the dimensions investigated and obtained from the point of view of the end users and clients as protagonists of these two test sites.

End user side

Attitude and affective response towards the robot: Overall, the end users' attitude towards the robot is differing. Both end users are generally satisfied with the robot's features do not consider the robot as an intrusion in their private home life. They have a minimum apprehension for possible management difficulties related to the use of the robot at home. However, compared to the end user **F 72yr** of Test Site 4, the **M 74 yr** end user of the Test Site 7 does not recognize the benefits and the advantages of the Giraff robot related to his needs. The end user **F 72yr** shows a good level of satisfaction towards the Giraff's functionalities and features and does not perceive a psychological distance between her and the robot. While the end user **M 74yr** shows a decent satisfaction towards the Giraff's functionalities, he experiences a psychological distance between himself and the robot.

The different attitude toward the robot emerges very clearly in terms of affective response. The end user F 72yr of Test Site 4 experiences a very pleasurable engagement with the robot in terms of positive affects compared to the M 74yr end user of the Test Site 7 who reported a rather negative affective response towards the use of the telepresence robot.

Robot Acceptance: over time, the Swedish end users don't show a complete and satisfactory social and functional acceptance. They are uncertain about the ability of the robotic system to adapt to the everyday life needs (PAD), ease of use of the robot (PEOU) and its usefulness (PU).
The end users' intention to use (ITU) the robot over a longer period in time decrease during the use experience. In addition, their perception that people who are important to them think he should or should not use the robot (SI) does not have value in the experience of end users.
They are also uncertain with respect to the pleasantness of their feelings of joy associated with the use of the robot (PENJ).
The use of the robot does not evoke feelings of anxiety (ANX) in either of the two end users.
The **72yrF** end user of Test Site 4 has more positive feelings about the appliance of the robot (ATT) and she perceives more factors in the environment that facilitate use of the telepresence system (FC) than the **M 74yr** of Test Site 7 does. Over time, his answers show a tendency to have a unfavorable attitude towards the use of the robot and clear uncertainties about the usefulness, the ability of the robotic system to adapt to the everyday life needs and the integrity and reliability of the robot.

Initially, the **72yr F** end user of Test Site 4 was hesitant regarding the robot's performace regarding personal integrity and reliability (TRUST) but during the experience she became more convinced and trusted that the robot was reliable and would not interfere with personal integrity..

Psychosocial impact of the robot on the end user's quality of life: the different use experience of the two older end users is describable also in terms of psychosocial impact of the robot. For the end user **F 72yr** of Test Site 4 the frequent use of the robot has affected different important aspects of her quality of life involving improvements especially in terms of positive impact on self-confidence, self-esteem and emotional wellbeing (Self-Esteem subscale of PIADS) and encouraging

effect of a device on functional independence, performance and productivity (Competence subscale of PIADS). On the contrary, the occasional use of telepresence robot did not have a positive psychosocial impact on the everyday life of **M 74yr** end user of the Test Site 7. The low usage of the Giraff has lead to a decrease in feeling of pleasure and an increase in frustration related to the use of robot (Self Esteem subscale of PIADS).

Telepresence dimensions: only for end user **F 72yr** of Test Site 4 it is possible to affirm that the person has a high-quality telepresence experience.

Client side

Expectations toward the telepresence system Giraff: confirmation of initial expectations (at the time S0) varies greatly between the two clients.

In particular, initial Client's 4 expectations are confirmed between S0 and S2. During the long-term use experience, the telepresence system Giraff maintains an added value for the user as an aid to:

- support in familiar caregiver role;
- offer more reassurance at distance;
- alleviate the need of client's presence;
- have more stable and frequent contact;
- alleviate end user's reliance on client;
- support in the management of unexpected events.

Nevertheless, at time S4 the client does not seem to feel any effect due to the removal and the added value of the system highlighted during the period of use is not confirmed in the period of disuse. It is possible that the reason for this is the fact that the client user lives at a 12h time difference from the end user. At this distance, his possibilities to offer anything other than social support is limited. This support can also take place via Skype, their previous main means for interaction.

From the point of view of Client 7, the high initial expectations (S0) on the ability of the system to be able to offer more stable and frequent contact, to alleviate the need of client's presence and the end user's reliance on client are rejected. The system has only partially fulfilled these functions and moderately offered more reassurance at distance. The system has not been able to meet the client's expectations due to the fact that the client did not manage to connect during most of his attempts. Therefore, the client does not consider the system to have been an actual valid help to support him in his friendly caregiver role and in the management of unexpected events. The telepresence robotic system represents also a potential element of intrusion in the end user's domestic life.

The disconfirmation of expectations evaluated at time S2 is also confirmed in step S4 after the removal of the system. In particular, the client 7 assumes that the disuse of Giraff system simplify the end user's interaction with the client.

Usability of the system's interface: the level of subjective usability is high for both clients. This result is also confirmed by the questionnaire on the usability of the system we developed ad hoc, which shows scores sufficiently high over time but it is useful to individuate some critical aspects of the usage for specific functions and commands.

For Client 4 the commands of Stop, Go backwards and Navigation have an uncertain ease of use over time at S2. In addition, the client does not perceive a satisfactory Safety of movement. It should be noted here that the connection between Fiji and Sweden is associated with a lag while interacting both via Giraff and Skype. At the final interview conducted when the robot was removed, the client user informed that the system had become easier to user over time.

Client 7 perceives a clear and critical decline of usability of commands associated with docking function and with check battery status.

Psychosocial impact of the robot on the end user's quality of life and affective response: overall the positive psychosocial impact on the Client 4 user's life related to the use of Giraff system is above all in terms of the willingness to try new experiences and feeling of well-being perceived in relation to the use of robot (Adaptability subscale of the PIADS).

For the Client 7, very slight improvements emerge in terms of the small impact of the robotic device on functional independence, performance and productivity (Competence subscale of the PIADS) and on individual willingness to try new experiences and feeling of well-being (Adaptability subscale of the PIADS).

Also from the clients' point of view, the different use experience of the secondary users emerges very clearly in terms of affective response. The Client 4 experiences more positive affects toward the telepresence system than negative ones, compared to Client 7 whom experiences ambivalent affects.

Telepresence dimensions: only for the Client of Test Site 4, it is possible to affirm the secondary user has a good telepresence experience especially in terms of Perceived behavioral interdependence, Perceived psychological engagement, Social richness, Social Presence and Perceptual Realism. The client perceives less the sense of Spatial presence and Co-presence.

These results are also supported by the interviews with the participants. Indeed they confirmed that the results for the two different test sites vary. One of the reasons for this is the fact that the Testsite 4 end user was using Skype to interact with the client user at a high frequency prior to the deployment. The Giraff extended her possibilities to interact with her son and grandchild in a more natural way than what was possible using Skype. She found it very positive to be able to move around and show things or even have coffee together while interacting. As both the end user and client user put it, it is almost like being there. On the contrary, the end user at test site 7 normally interacted with his client users via the telephone or in person. As such, the Giraff was not perceived to extend the possibilities for interaction to the same extent.

Other likely important reasons for the varying results include: a) there were less technical issues with the Giraffs deployed at test site 4 than at test site 7 and b) the man often did not hear when the Giraff was ringing even after the volume of the ring signal was adjusted. This annoyed the client users who initially attempted calling many times. At the same time, the end user was annoyed about the Giraff never ringing. It is uncertain why the man did not respond to the calls. At times, the project participants from OCC noticed that the man did not respond when Giraff rang while they were in the end user's home. It is believed that the person sometimes did not want to respond as well.

Noticeable is that both end users would have wanted to know who the person calling is before responding to the calls. While this was possible if they were able to look directly at the screen facing the wall, they did not acknowledge this functionality. On later versions of the Giraff, the screen tilts outwards the room when there is an incoming call. The end user at testsite 4 was

positive to this when informed about the newer Giraff. The end user at test site 7 even said that he would have wanted to be able to check whether he had missed incoming calls, like on a phone. If this had been possible he would have wanted to return the call.

5   SPAIN Test Sites Results

In this section we provide a summary of the main results gathered from each test site in Spain. Specifically we report the feedback obtained from all the Swedish test sites for which it was possible to follow the evaluation methodology described in the previous section.

5.1   Test site Spain 1

The entire long term experience lasted 2 years, from May 2011 – August 2013

5.1.1 Participants

End User:
This user is a 65 years old woman. She is a healthy person who has no trouble carrying out their daily tasks. She is a widow and lives with one of her sons. The son who lives with her spends a lot of time away because of his job, so this end user is at home alone most of the day. She is not very familiar with the new technologies, but she is determined and able to learn how to use a system like the one presented in the project.

Her main reason for using the telepresence system is to feel closer to her other son, the one who does not live with her. Although she does not require any special care from a health point of view, she and her family consider making visits through the Giraff very useful to overcome a potential emergency or maintain a continuous contact.

Pilot User:
A 38 man years old man. He is a son of the end user. He lives in Málaga, not too far from his mother, but due to lack of time he can't visit her mother as much as he would like. He is a person very familiar with the technology. Because of his job, he uses the computer many hours a day and he is comfortable using it to visit his mother, to see how she is, chatting a bit and make sure everything goes well for her.

5.1.2 End User side

5.1.2.1 Psychological measures

Over time the scores on Geriatric Depression Scale (GDS) and on Short Form-12 Health Survey (SF-12) show scores substantially similar and indicative of relatively satisfactory physical and mental health status (PCS and MCS scores >20). Although the end user does not experience depressive symptom (score between 0-9), the scores from S0 to S4 on the Perceived Loneliness Scale (UCLA) indicate an experience of severe loneliness (UCLA score > 40). The feeling of loneliness is partially also reflected in the perceived social support.

In the pre-adoption phase (S0), the total score of the Multidimensional Scale of Perceived Social Support Scale (MSPSS) is 56 (range score 12-84; the higher the score the higher the perceived social support). In particular the three subscales scores indicate that the end user perceives a higher social support from family and significant other persons with respect to that poorly received from the friendships network. Over time the family and significant other persons remain relatively stable continuing to be the main sources of perceived social support (Figure 21).
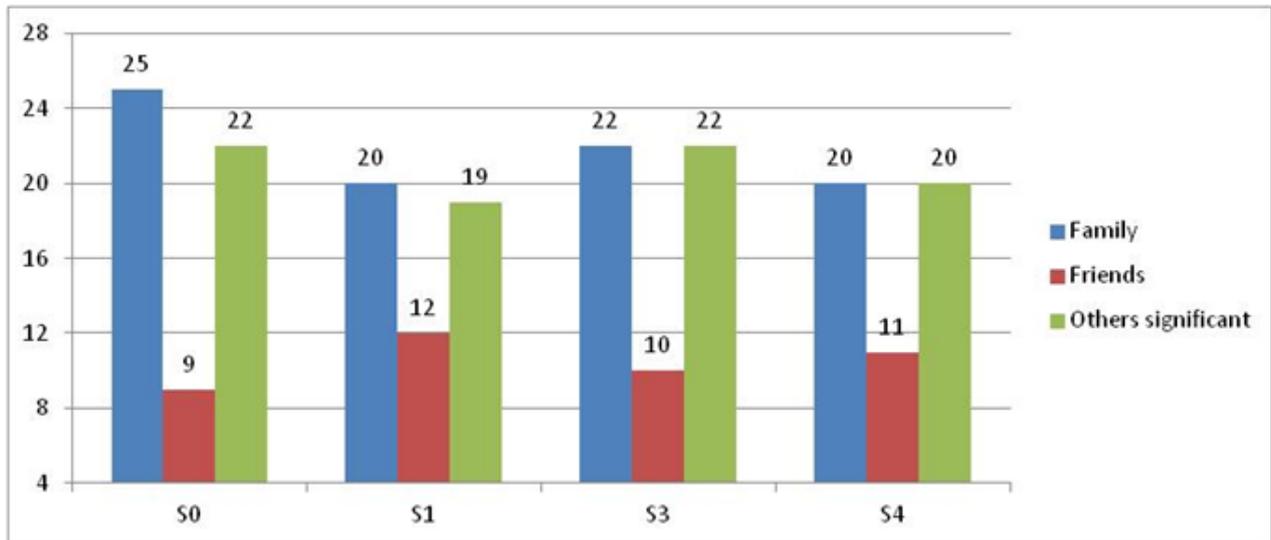
Figure 21: Total scores for each dimensions of MSPSS obtained from the sum of the responses from the items in each of the three dimensions (range score 4-28).

5.1.2.2 Robot Acceptance

The mean scores of each construct of the Almere model acceptance constructs (see Figure 22) show an increase of Intention to Use (ITU), Perceived Usefulness (PU) and Social Influence (SI).
Perceived Ease of Use (PEOU) and Trust are constantly very satisfactory from the end user's point of view.
The attitude (ATT), Facilitating Conditions (FC), Perceived Enjoyment (PENJ) and Perceived Adaptiveness (PAD) remain moderately favorable during the whole use experience.
The moderate high scores of Anxiety (ANX) point out that the presence and the usage of the robot always evoke anxious feelings.
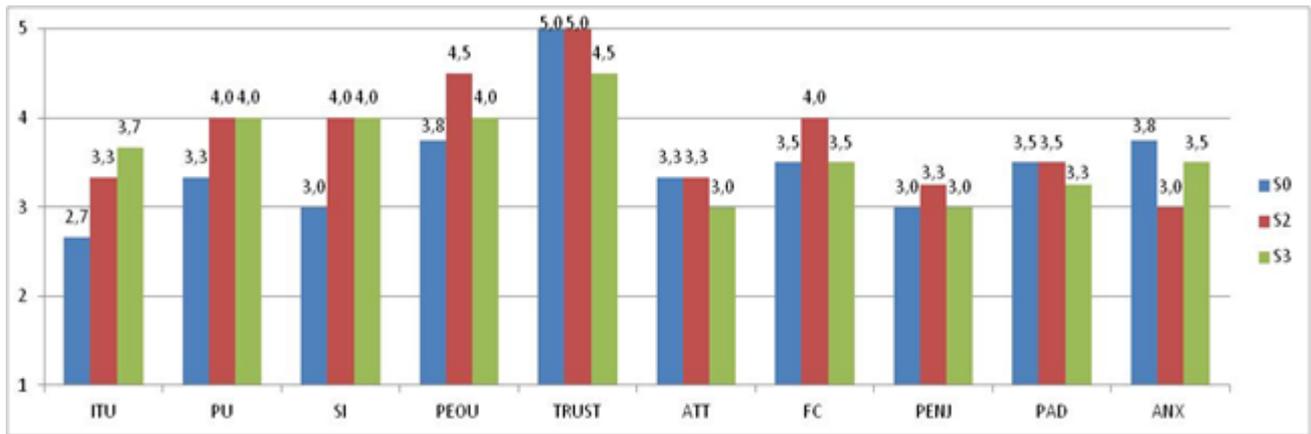
Figure 22: Mean scores for each Almere Model constructs
(5 points Likert scale, from 1= completely disagree to 5= completely agree)

5.1.2.3 Attitude and affective response toward the robot

During the robot's experience of use (Figure 23), the end user does not perceive a psychological distance between himself and the adopted aid (M=0.8) and feelings of intrusion into his domestic privacy (M=1.6).
He recognizes reasonably well the benefits and advantages related to the everyday use of the robot (M=2,5) showing a moderate satisfaction with the Giraff's functionalities and features (M=2,3). Nevertheless, the end user complains a slight apprehension for management difficulties (M=2.2).
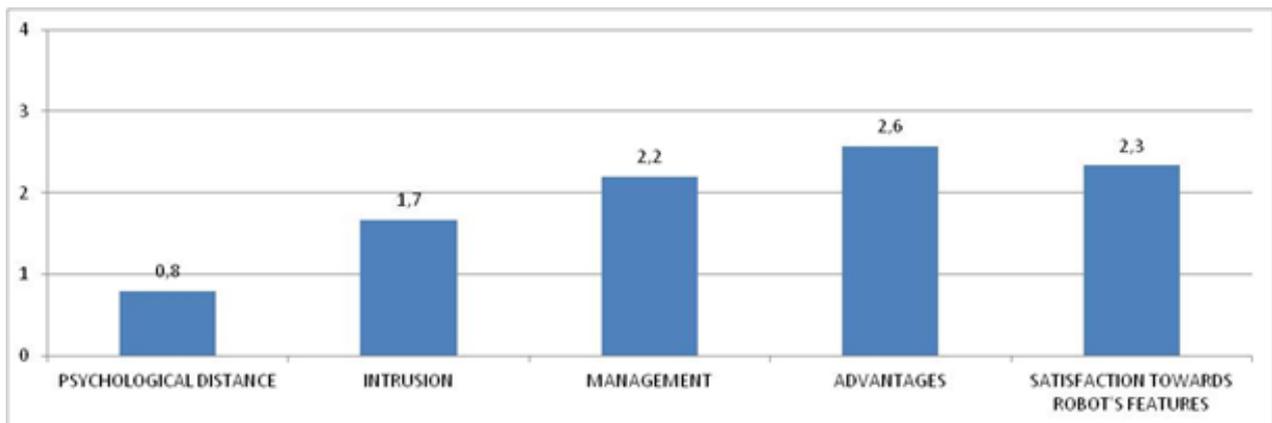
Figure 23: Mean scores for each dimension
(5 points Likert scale, from 0= completely disagree to 4= completely agree)

In terms of affective response, the end users reported a moderately positive affective response toward the use experience with the telepresence robot. Specifically, the score of subscales of the PANAS scale was respectively 28 for Positive Affects and 14 for Negative Aspects. The robot is assessed as rather interesting and reassuring but moderately pleasant, useful and cumbersome.

5.1.2.4 Telepresence dimensions

The analysis of the distribution of responses related to the ad hoc questionnaires adapted by the Temple Presence Inventory and the Networked Minds Social Presence Inventory (Figure 24) shows that the end user perceived a very low level of **Social Presence** (in terms of feeling of being together) and a moderate **Perceived Enjoyment** (degree of being enjoyable during the technology usage). Conversely, the user's perception of **Social Richness** (in terms of subjective experience of warmth and intimacy in the mediated Interaction), and of **Co-presence** (in terms of psychological connection to and with another person) are rather satisfactory.
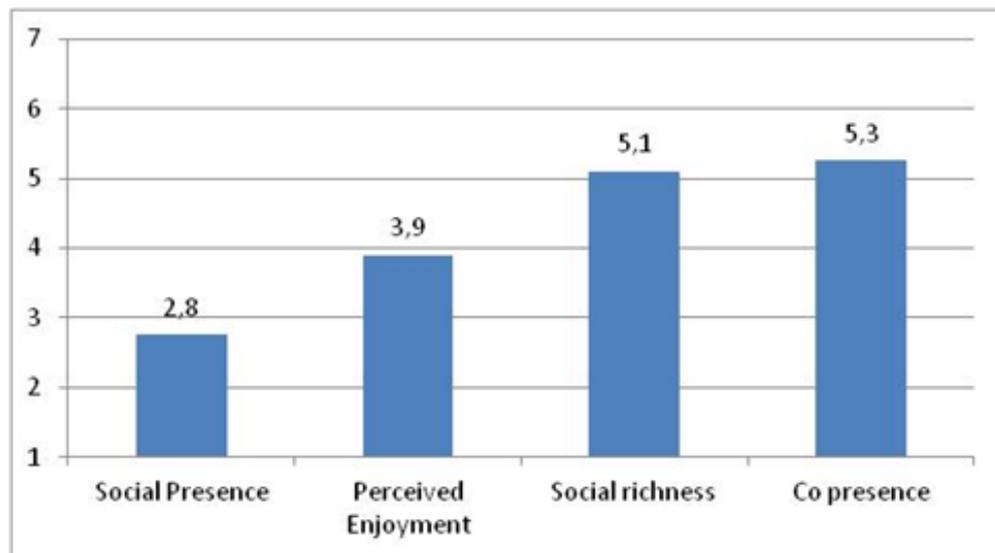
Figure 24: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

5.1.2.5 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

Considering the end user's perspective the robot did not have a strong psychosocial impact on everyday life (Figure 25). Comparing the scores of the three subscales of the PIADS questionnaire it is possible to note a small and more concrete improvement in terms of Competence (M=1) and Self Esteem (M=1).
Referring to perception of functional capability, independence and performance related to the use of the robot (Competence), the user perceives an enhancement in Capability, Self Confidence, Usefulness and Adequacy. In addition, the use of the robot has decreased the sense of Confusion.
In terms of Self Esteem, using of robot has a positive impact reducing individual Frustration and Embarrassment.
No real improvement in terms of ability has been found.
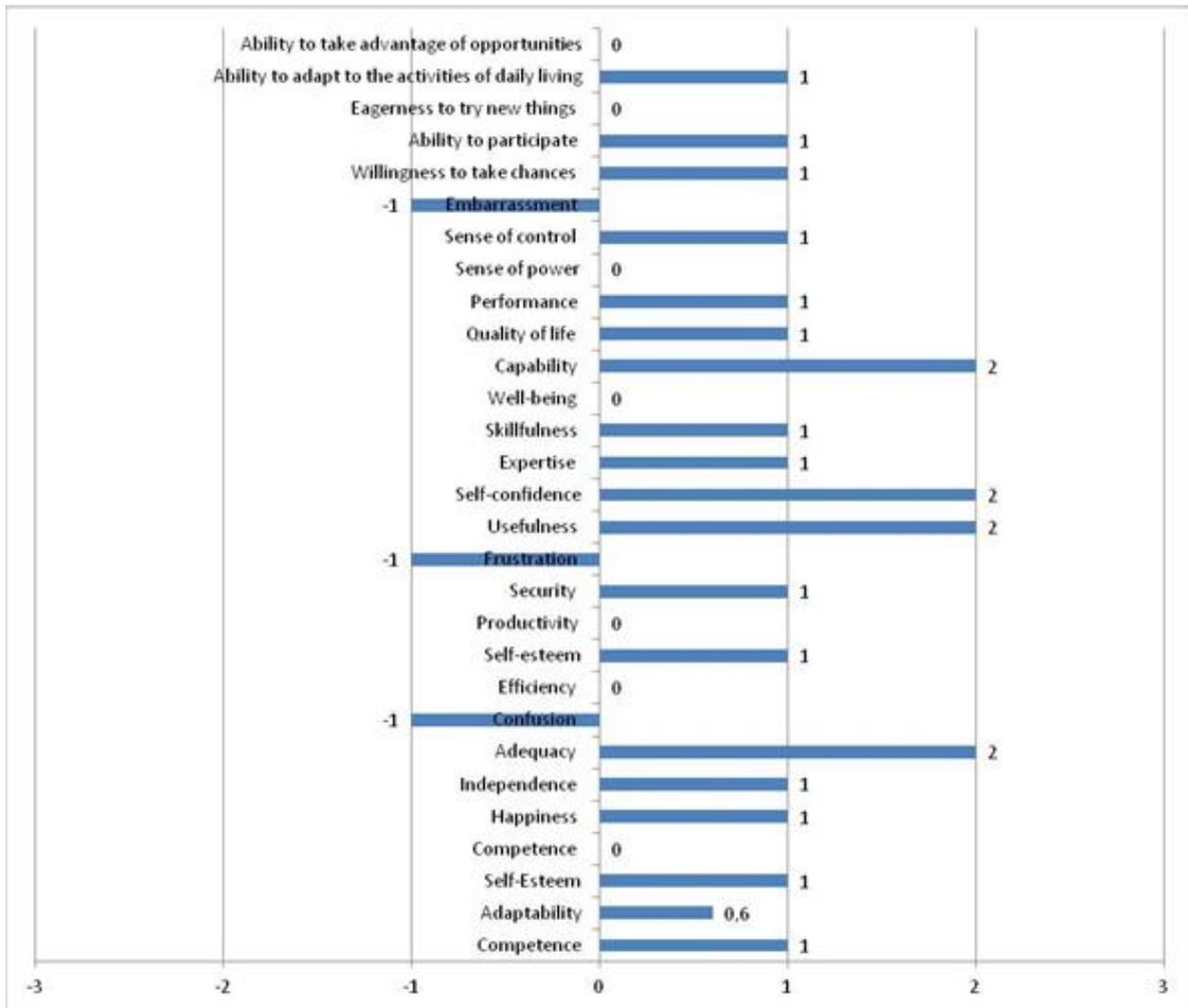
Figure 25: Mean score on three sub scale of Piads distribution of end user response.
Scale from -3 [Decreases] to + 3 [Increases]

5.1.3 Pilot side

5.1.3.1 Expectations toward the telepresence system

Most of secondary user's expectations, related to the use of the telepresence system as an aid to provide a service for remote assistance, are generally confirmed over time (Figure 26).
Specifically, at time S0 the secondary user does not believe that a telepresence system may be a threat to the domestic privacy of an older end user. This expectation is confirmed at time S2 and at the follow up step S4 along with the idea that the usage of the system does not have neither a negative impact on the human relationship nor on the opportunities for physically visits.
In addition, the use experience confirms at time S2 that the Giraff telepresence system is perceived as a very useful aid designed <u>to alleviate the loneliness of an older use and to support everyday communication.</u>
Over time experience, the expectations related to the sense of closeness with end user and the possibility to maintain more stable and frequent communication contacts through the

telepresence system show a slight discrepancy. At time S2, these functions are more moderately perceived by the client.

In the follow up step (S4) the client assumes that the disuse of the telepresence system has involved moderately a smaller amount stable and frequent communication contacts, a slight increase of end user's perception of loneliness, a small lack of support for everyday communication and a fewer sense of distance from the end user.

Figure 26: Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system
(5 point Likert scale from 0=not at all to 4=very much)
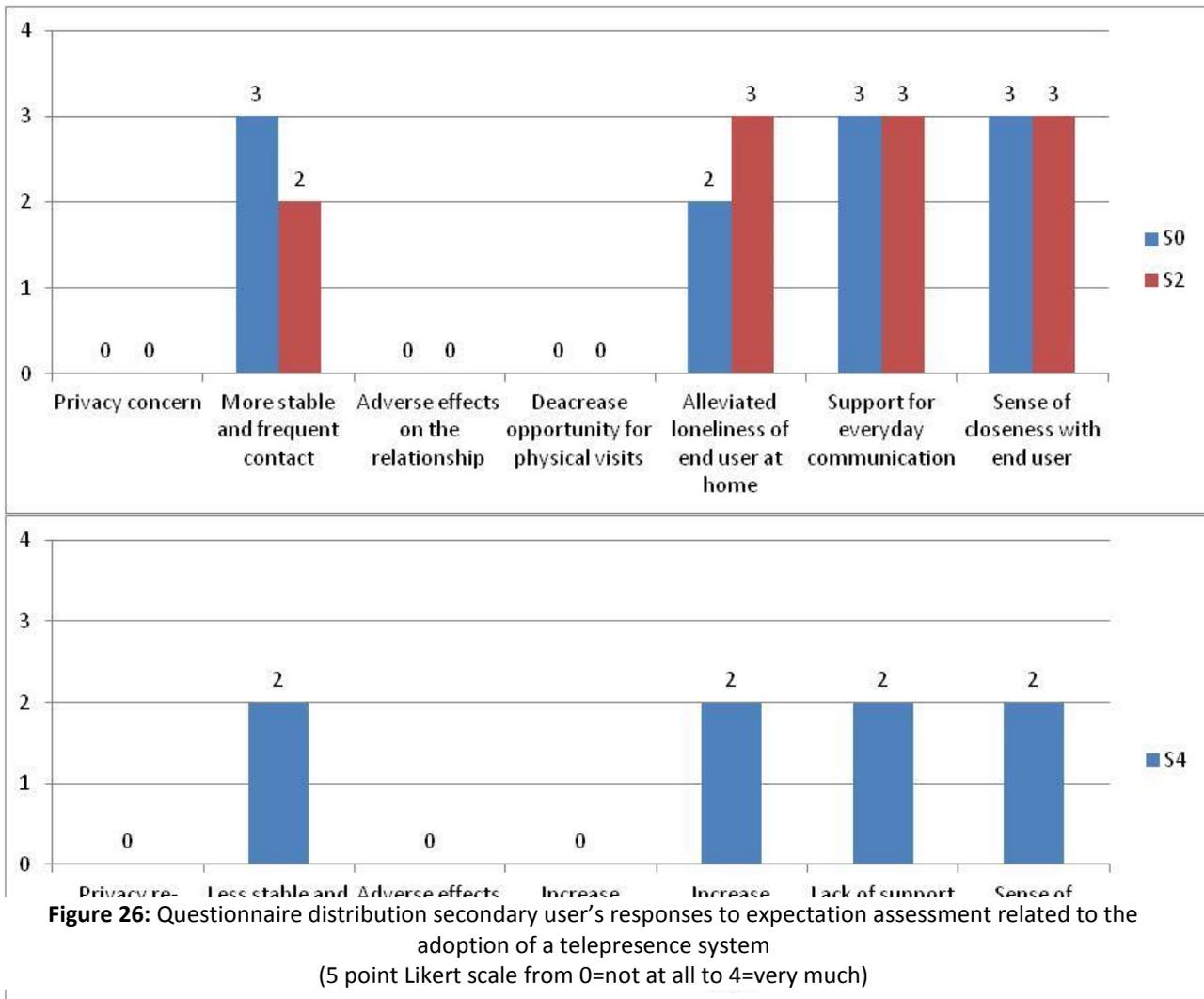
5.1.3.2 System Usability Scale - Ease/Difficulty of learning and use functions' and commands' interface

The analysis of the SUS questionnaire showed a score of 60 indicating a sufficient but not optimal level of subjective usability of the Giraff's client interface (see Figure 27). This result is also confirmed by the questionnaire on the usability of the system we developed ad hoc for the case study, which shows scores not particularly high at S1 (M=1,55). In particular, the functions related to the docking (docking, position for docking and check the docking status) and the command of U-turn and Stop are very difficult. In addition, the secondary user has difficulty in seeing and hearing the end user through the interface.

After the first period of usage (S2), the usability of the system improves for most of all functionalities of tele-operation but functions related to the docking, audio and video remain difficult.
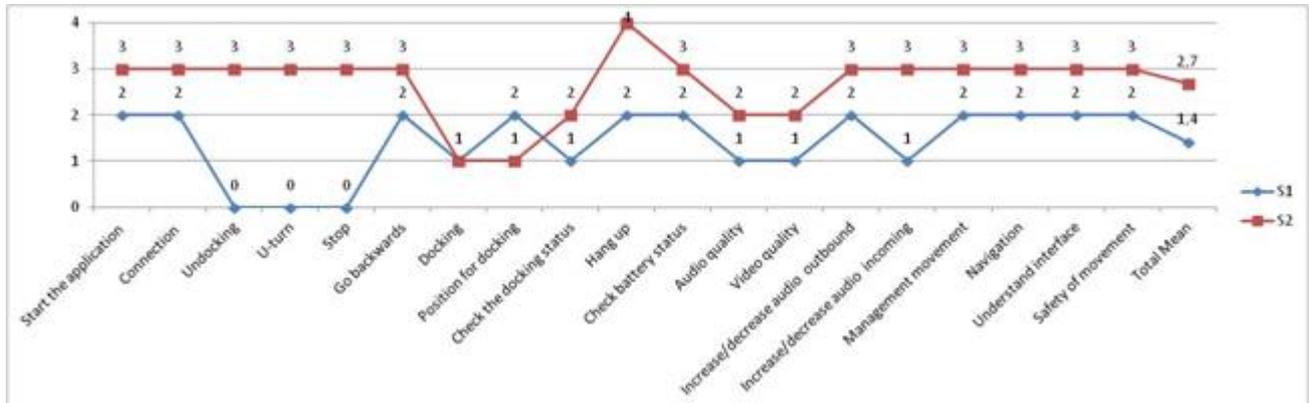
Figure 27: Questionnaire distribution on pilot response to usability assessment
(5 points Likert scale from 0 = very difficult, 4 = very easy)

5.1.3.3 Telepresence dimensions

Regarding the telepresence dimensions of T*emple Presence* and *Networked Minds Social Presence Inventory* (Figure 28) the secondary user experiences a moderate sense of Spatial presence (sense of being physically located in a virtual environment) and of Perceptual Realism (experience in which the mediated interaction accurately simulates or reproduces the sensory experience that would be expected in the non-mediated interaction).

He reports high degrees of Social Presence (feeling of being together), Perceived behavioral interdependence (extent to which a user's behavior affects and is affected by the interactant's behavior) and Perceived psychological engagement (extent to which the user feel mentally immersed in the experience).

Finally, sense of Co-presence (psychological connection to and with another person) and Social richness (subjective experience of warmth and intimacy in the mediated interaction) are perceived very strong.
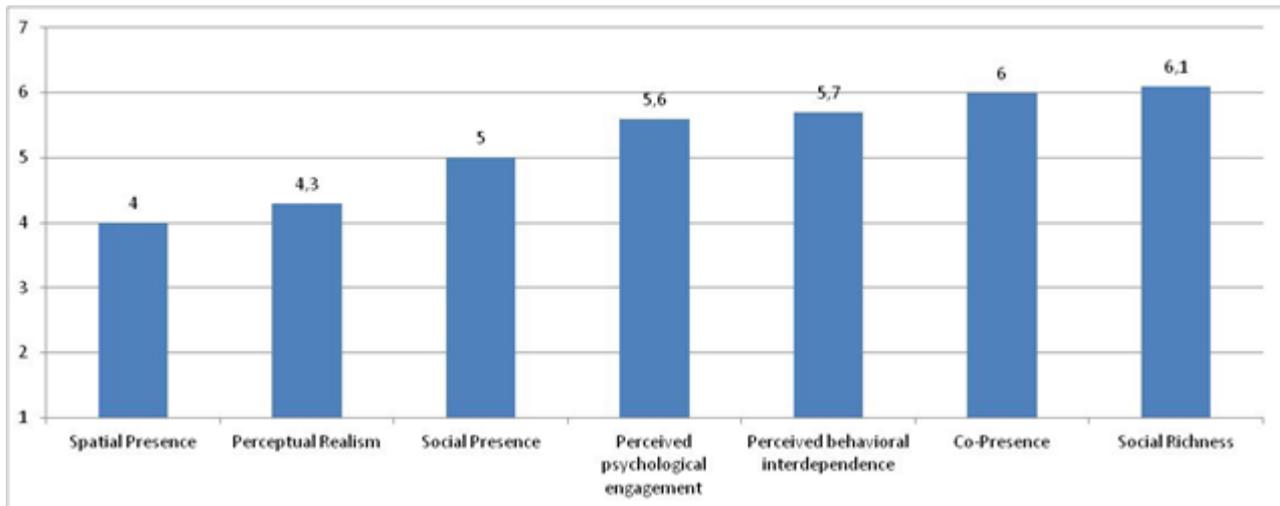
Figure 28: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

5.1.3.4 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

The analysis on the PIADS scale reveals that overall the service offered through Giraff system had have a rather strong psychosocial impact on the secondary user's life (Figure 29), causing remarkable changes in **Competence** (M=1.7) and **Self Esteem** (M=1.6).

From the point of view of the Competence sub-scale it is possible to say that the main improvements has been obtained especially with respect to Performance, Quality of life, Capability, Skillfulness, Usefulness, Confusion and Adequacy.

In terms of Self Esteem, using of robot has a positive impact on the one hand increasing the Happiness, Security and Self Confidence and the other side decreasing Frustration and Embarrassment.

An explicit impact is also found in the **Adaptability** (M=1,2) and results shows that in particular the telepresence system has improved mainly the Well-being and Ability to adapt to the activities of daily living.
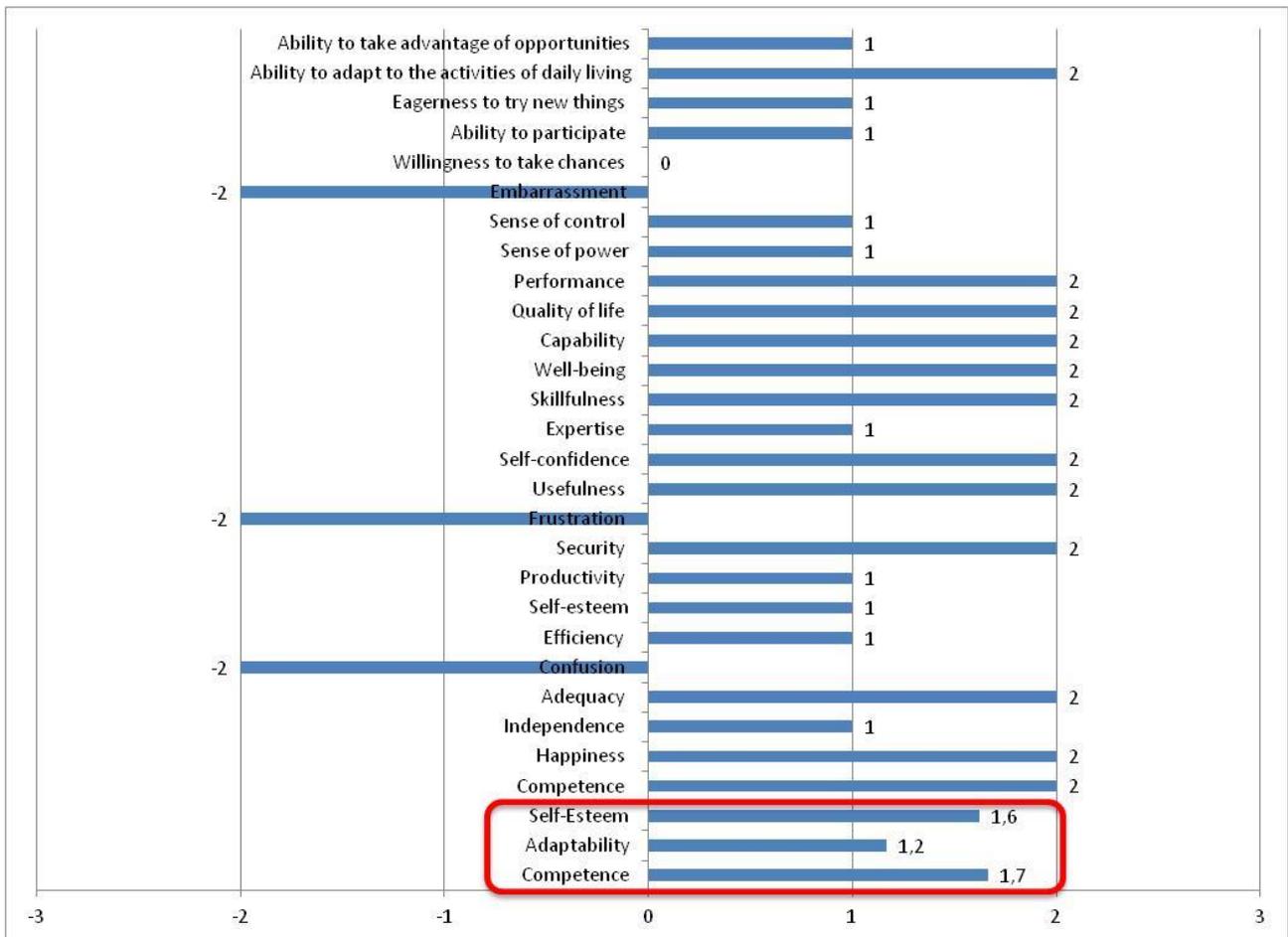
Figure 29: Mean score on three sub scale of Piads distribution of end user response.
Scale from -3 [Decreases] to + 3 [Increases]

5.1.3.5 Affective state related to the use experience and interaction through telepresence system: PANAS scale

Positive affect subscale show higher scores (33) than Negative Affect subscale (10) and this result indicate that end experiences a pleasurable engagement with the technology.

5.2 Test site Spain 2

The entire long term experience lasted 18 months, from November 2011 – March 2013

5.2.1 Participants

End User:

In this case, the end user is a widowed 80 year old man. He lives alone, he often speaks with his relatives by phone and his granddaughters visit his house daily for about an hour to do housework. He is a very dynamic person despite his age, has a good sense of humour and is familiar with the technologies. He is able to handle a smartphone or PC, check or send emails, install a SW program

on his computer, etc. Although his condition and abilities are so good, because of his age he regularly visits the Health Centre to track his health status. He has a good relationship with his doctor, who participates as a Healthcare Professional Pilot user in this test site. Both think that this system helps to have better communication between doctor and patient.

Pilot User:

The main secondary user in this test site is a doctor at the Estepona Health Center (SAS Costa del Sol), he us very interested in research and applications of new technologies to improve the quality of the care service provided to his patients. Within this context, he finds very interesting using a system like the one presented in the ExCITE project for a more efficient and personalized healthcare. For this reason, the user is interested in making sporadic to test sites 1 and 3 calls (although they were not his patients) for a more complete experience.

Regarding pilot users in the role of relatives, one of his daughters wants to contact her father more closely than making a phone call. Her main desire is to be able to physically see her father because she thinks the interaction is much more realistic, more satisfying for both and provides more real information about the health and spirit of his father.

5.2.2 End User side

5.2.2.1 Psychological measures

Over the time the results of the Geriatric Depression Scale (GDS) and the Short Form-12 Health Survey (SF-12) show scores substantially similar and indicative of a rather good physical and mental health status. Although the end user does not experience depressive symptom, the scores from S0 to S4 on the Perceived Loneliness Scale (UCLA) indicate an experience of severe loneliness (UCLA score > 40).

The feeling of loneliness is also reflected in perceived social support. In the pre-adoption phase (S0), the total score of the Multidimensional Scale of Perceived Social Support Scale (MSPSS) is 44 (range score 12-84; the higher the score the higher the perceived social support). In particular the three subscales scores indicate that the end user perceives a higher social support from family with respect to that poorly received from the friendships network and/or from significant other persons close to the user. Over time the family and friendships network remains relatively stable continuing to be the main source of perceived social support. Conversely, the perceived social support from significant other persons noticeably increases (Figure 30).
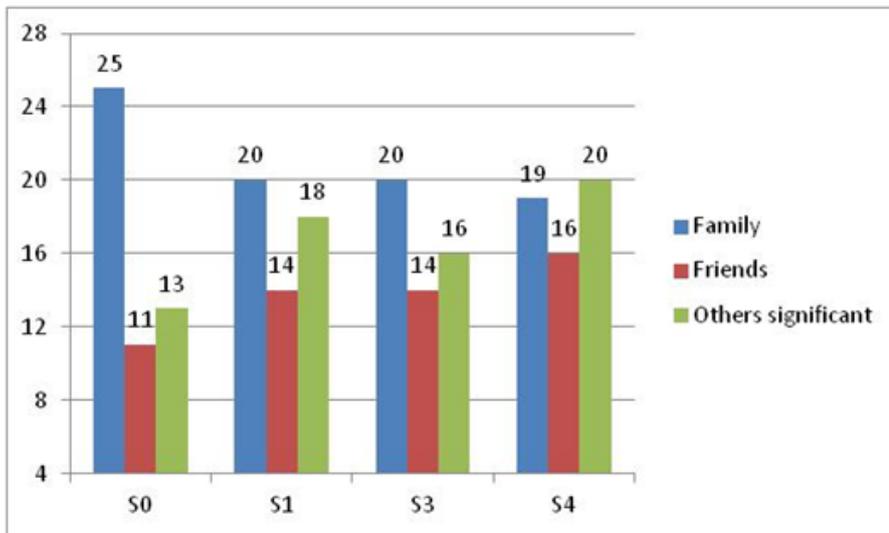
Figure 30: Total scores for each dimensions of MSPSS obtained from the sum of the responses from the items in each of the three dimensions (range score 4-28).

5.2.2.2 Robot Acceptance

The mean scores of each Almere model acceptance constructs (Figure 31) show a constant trend over time for Perceived Ease of Use (PEOU) and Usefulness (PU), Intention to Use (ITU) and Social Influence (SI) which are satisfactory for end user's point of view.

The attitude (ATT) of end user toward the robot is initially moderately favorable, but over time it becomes more positive. Similarly, Facilitating Conditions (FC)and Perceived Adaptiveness (PAD)increase during the user experience. User experience has also a positive impact in terms of Anxiety. Initially the presence and the usage of the robot evoke anxious feelings that gradually become less strong.

Although the end user shows a good acceptance of the robot, there is a decrease over time of the Trust and of the feelings of joy/pleasure (PENJ) associated with the use of the robot.
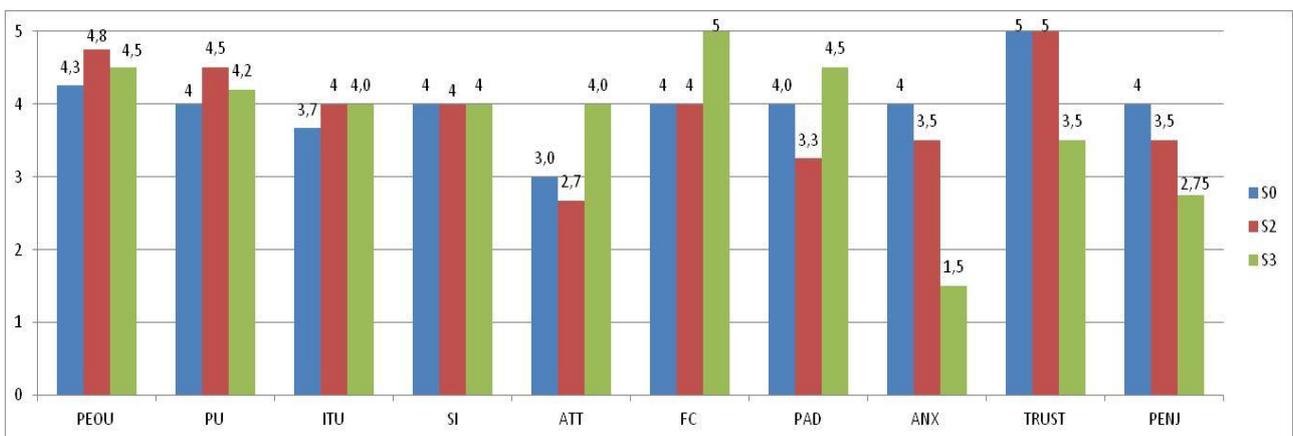
Figure 31: : Mean scores for each Almere Model constructs
(5 points Likert scale, from 1= completely disagree to 5= completely agree)

5.2.2.3 Attitude and affective response toward the robot

During the robot's use experience, the end user does not perceive a psychological distance between himself and the adopted aid (M=1) and feelings of intrusion into his domestic privacy (M=1,2). In addition, he is rather satisfied of the Giraff's functionalities and features (M=2,5) and he recognize benefits and advantages related to the everyday use of the robot (M=2,8). Nevertheless, he shows also a slight apprehension for management difficulties (M=2.2). (Figure 32).

The PANAS scale shows an average value of positive affect (30) toward the Giraff system that is decisively higher than the negative affect scale (12). In particular the robot is evaluated as very pleasant, interesting and reassuring.
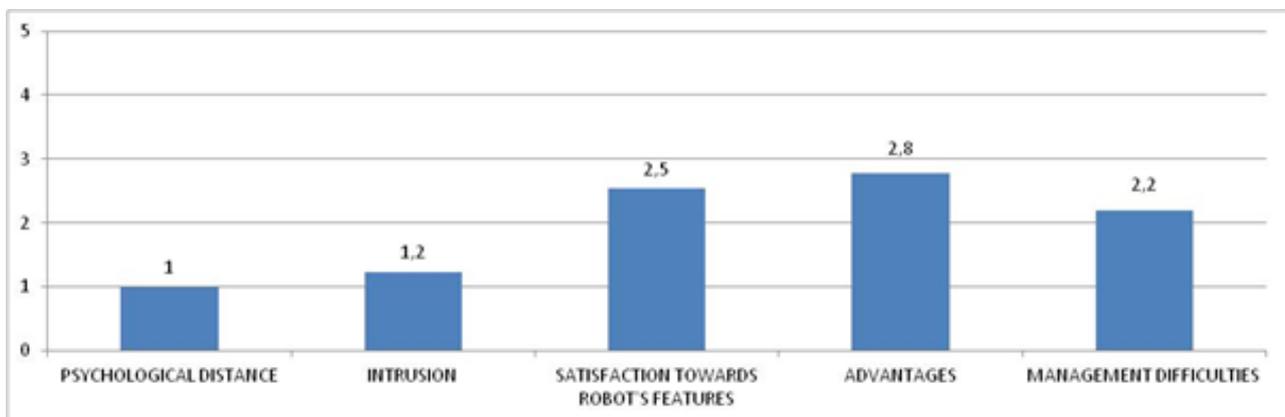
Figure 32: Mean scores for each dimension
(5 points Likert scale, from 0= completely disagree to 4= completely agree)

5.2.2.4 Telepresence dimensions

Analysis of the distribution of responses related to ad hoc questionnaires adapted based on the *Temple Presence Inventory* and the *Networked Minds Social Presence Inventory* (see Figure 33) show that the end user perceived a high level of **Social Richness** (in terms of subjective experience of warmth and intimacy in the mediated Interaction), and **Co-presence** (in terms of psychological connection to and with another person). Conversely, the end user show a moderate perception of the **Social Presence** (in terms of the feeling of being together), and of the abovementioned **Perceived Enjoyment** (degree of being enjoyable during the technology usage)
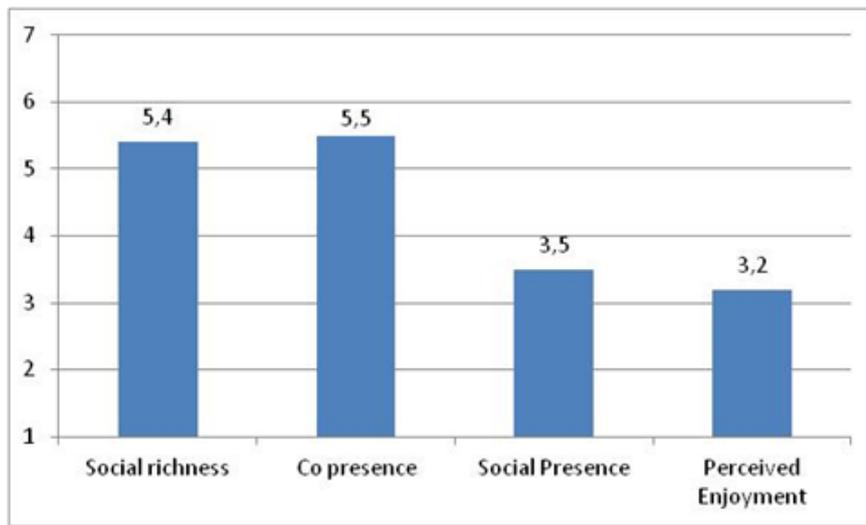
Figure 33: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

5.2.2.5 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

Analysis on the PIADS scale () reveals that the use of the robot has had a positive psychosocial impact on the secondary user's life especially with respect to **Adaptability** (M= 1.2) that is willingness to try new experiences and feeling of well-being perceived in relation to the use of robot. A substantial increase occurs in the ability to participate.

A small impact of Giraff in end user's everyday life is recognized in terms of Competence (M = 0.8), that is perception of functional capability, independence and performance. Results show that in particular the robot has improved mainly the adequacy and the capability.

The system does not have a evident impact on Self-esteem (M= 0.5).
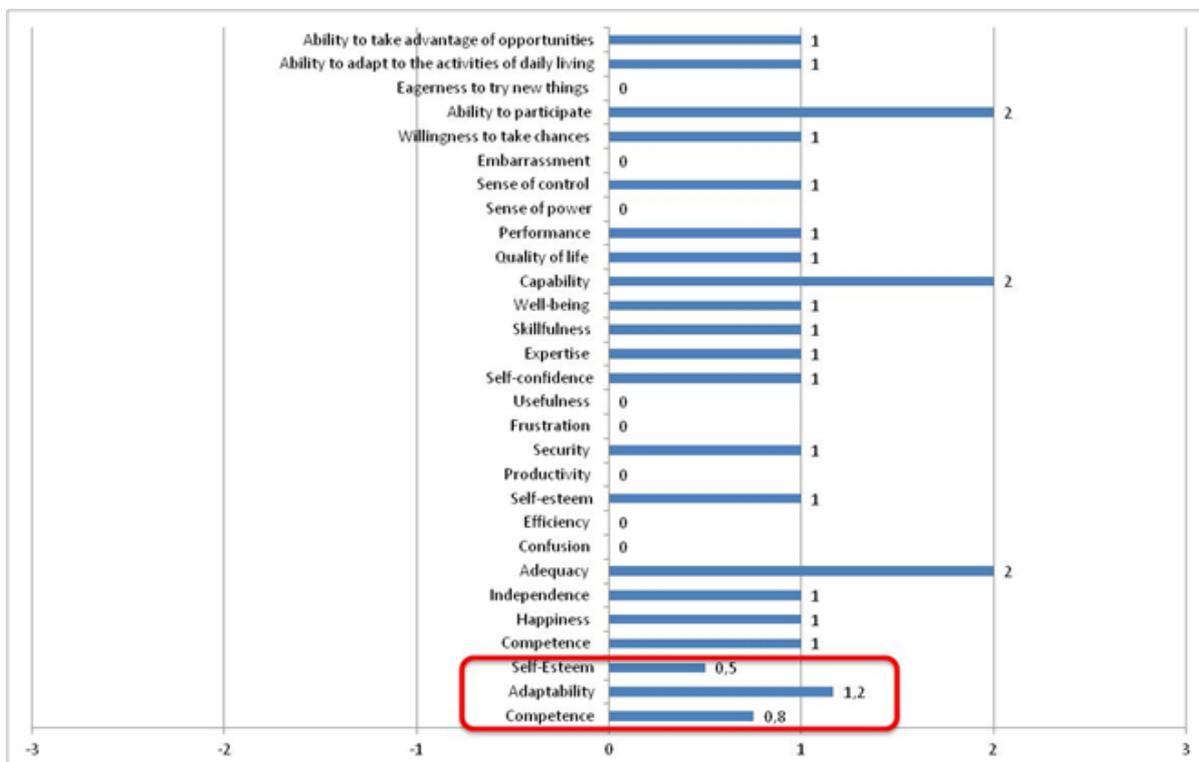
Figure 34: Mean score on three sub scale of PIADS distribution of end user response.
Scale from -3 [Decreases] to + 3 [Increases]

5.2.3 Pilot side

5.2.3.1 Expectations toward the telepresence system

Secondary user's expectations, related to the use of the telepresence system as an aid to provide a service for remote assistance, are generally confirmed over time (Figure 35)

Specifically, the healthcare provider does not believe that a telepresence robot may be a threat to the privacy of an older end user. Respect to the support that the system can stand for own profession, the secondary user does not expect that the telepresence system can improve the older user's time management and alleviate the end user's need for home help service.

Although the system is perceived as a good support for remote assistance service, for the management in case of unexpected events and for moderately more stable and frequent contacts, the secondary user does not feel really reassured by the presence of the robot and by functionalities of the system.

The interaction mediated by the robot may not be an easy way of communication for an older user. Nevertheless, the healthcare provider believes that the use of telepresence does not have adverse effects on human relationship and it is not likely to provide a low quality service.

At S4, after the conclusion of the case study, the expectations expressed at S0 and at S2 are confirmed. The secondary user recognizes that without the telepresence system he feels the need for a support device for remote assistance and for the management of any unexpected events, confirming the potential validity of the system for this purpose (Figure 36)
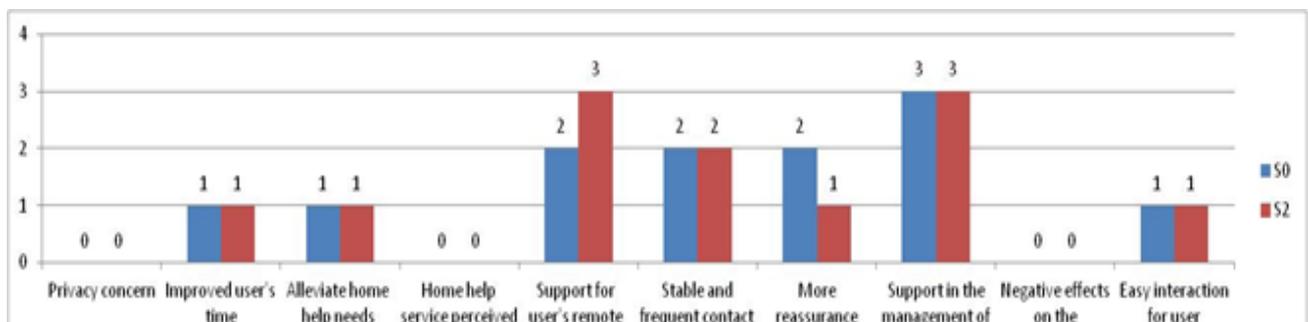
Figure 35: S0- S2 Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system (5 point Likert scale from 0=not at all to 4=very much)
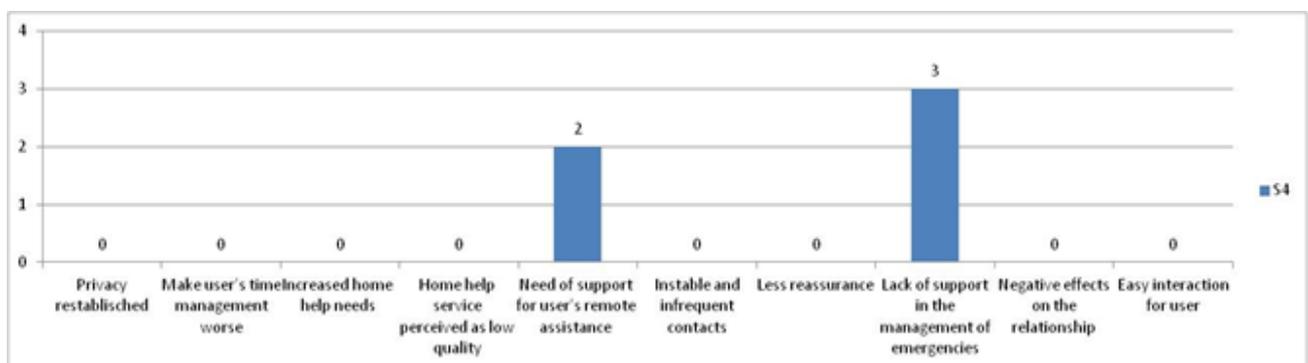
Figure 36: S4 Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system (5 point Likert scale from 0=not at all to 4=very much)

5.2.3.2 System Usability Scale - Ease/Difficulty of learning and use functions' and commands' interface

The analysis of the SUS questionnaire showed a score of 65 indicating a sufficient but not optimal level of subjective usability of the Giraff's client interface. This result is also confirmed by the questionnaire on the usability of the system we developed ad hoc for the case study, which shows scores not particularly high at S1 ().

After the first period of usage (S2), the usability of the system improves for most of all functionalities of the system. Nevertheless some aspects of the usage remained difficult for specific activities like as docking, moving the robot to the docking station and making sure the robot is charging battery.
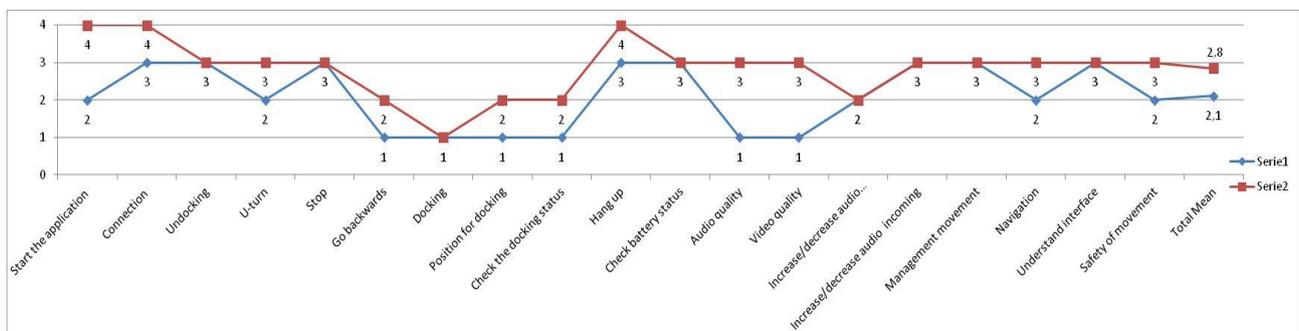
Figure 37: Questionnaire distribution on pilot response to usability assessment
(5 points Likert scale from 0 = very difficult, 4 = very easy)

5.2.3.3 Telepresence dimensions

Regarding the telepresence dimensions of *Temple Presence* and *Networked Minds Social Presence Inventory* the secondary user does not perceive a satisfactory level of **Spatial presence** (sense of being physically located in a virtual environment), but he report high degrees of **Perceived behavioral interdependence** (extent to which a user's behavior affects and is affected by the interactant's behavior), **Perceived psychological engagement** (extent to which the user feel mentally immersed in the experience), **Social Presence** (feeling of being together) and **Perceptual Realism** (experience in which the mediated interaction accurately simulates or reproduces the sensory experience that would be expected in the non-mediated interaction).

The experiences of **Social richness** (subjective experience of warmth and intimacy in the mediated Interaction) and **Co-presence** (psychological connection to and with another person) are judged as highly perceived. (Figure 38)
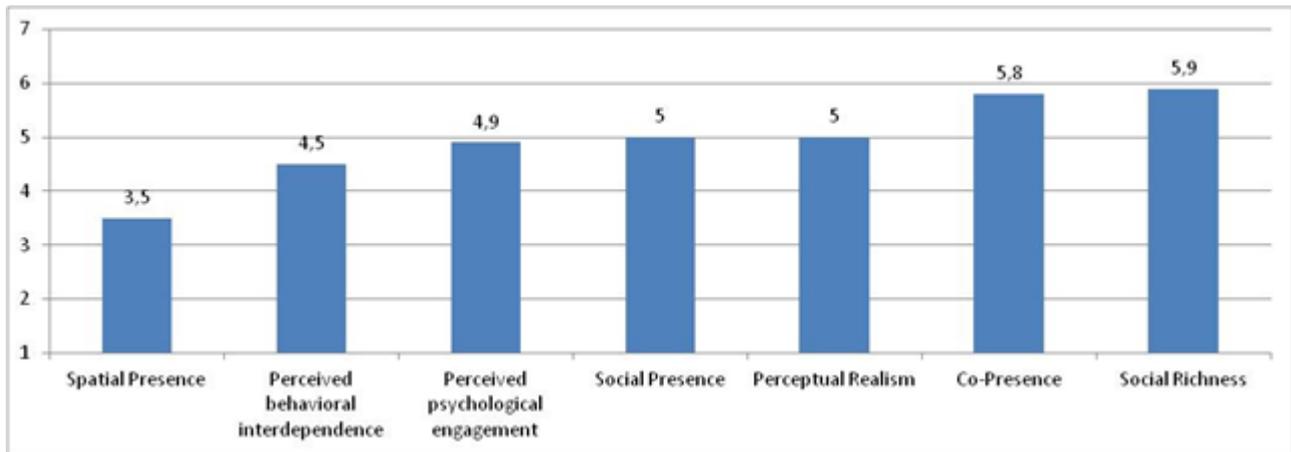
Figure 38: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

5.2.3.4 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

Analysis on the PIADS scale reveals that overall the service offered through the telepresence system have a slight psychosocial impact on the secondary user's life (). From the point of view of the three sub-scales of the PIADS it is possible to say that the main improvement has been obtained especially with respect to **Competence** (M=1.33), with a considerable increase in the feeling to be helpful to yourself and others (Usefulness), in the effective management of day to day tasks (Efficiency), in capacity of handling life situation (Adequacy) and in ability to act decisively (decrease of Confusion).

Another small improvement was found in **Self-Esteem** (M=1.25) and **Adaptability** (M=1). In particular, in terms of Self-Esteem the system has improved the feeling to have influence over own life (Sense of Power), the trust in own abilities (Self Confidence) and the individual safety perception (Security).
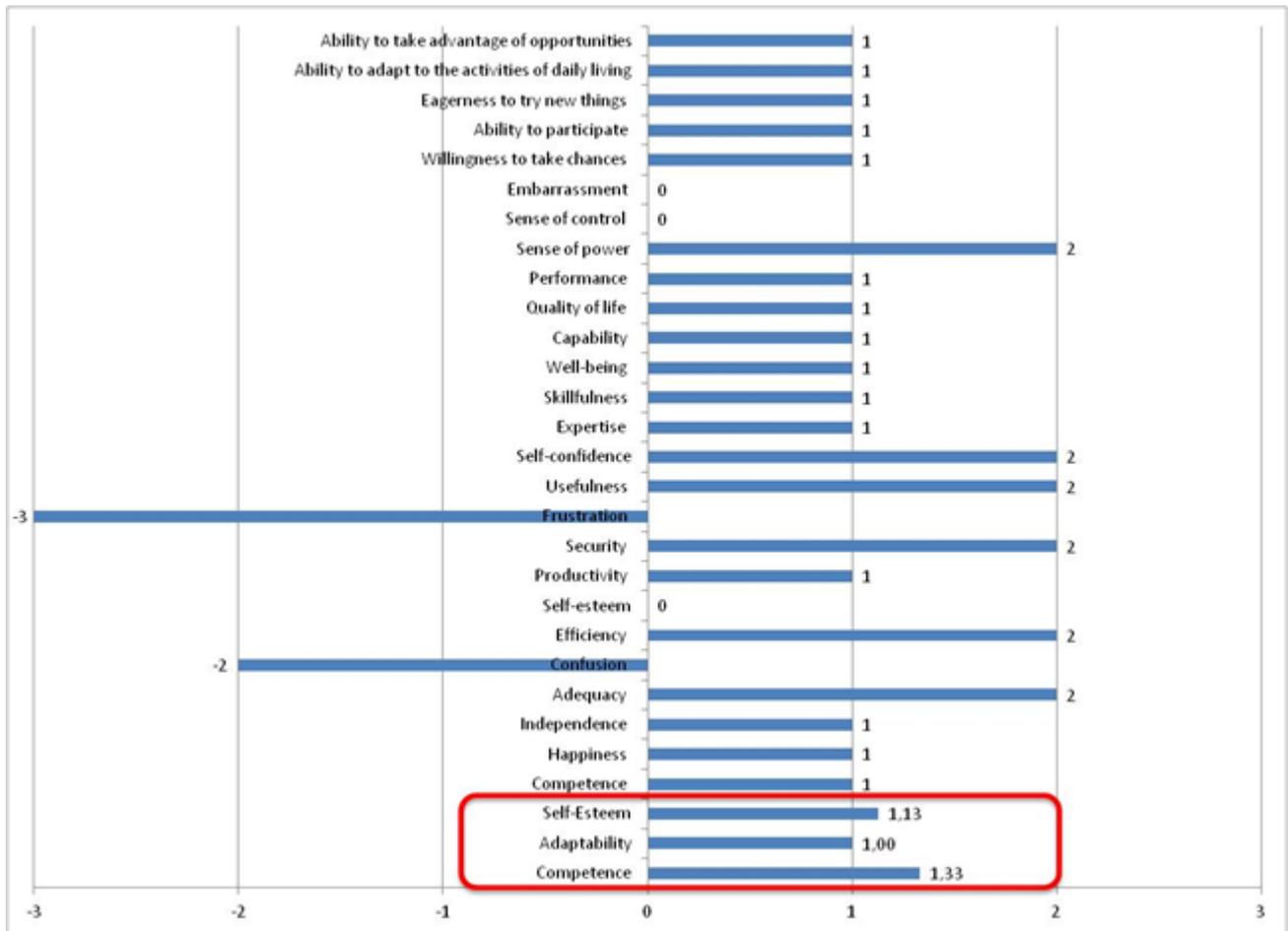
Figure 39: Mean score on three sub scale of PIADS distribution of end user response.
Scale from -3 [Decreases] to + 3 [Increases]

5.2.3.5 Affective state related to the use experience and interaction through telepresence system: PANAS scale

The PANAS scale shows an average value of positive affect (34) toward the Giraff system that is higher than the negative affect scale (10).

5.3 Test site Spain 3

The entire long term experience lasted 1 year, from January 2012 – March 2013

5.3.1 Participants

End User:

This user is a 77 years old widow. She has specific conditions regarding the other two Spanish end users, she is not as independent as they are, since she needs to use a wheelchair to get around. Because of her limitations, she has a full-time caregiver at home to help her every day. Her physical limitations do not allow her to visit somebody or doing housework by herself, so this person is more likely to be bored than others. She lives in Coín, a town 45 kilometers away from Málaga, where one of his sons lives. The main reason to use this telepresence system is to include a new element in his life which allows her to see her son more often and make her life more dynamic thanks to possible visits from other relatives.

Pilot User:

A 55 years old son of the end user. He is very interested in technologies and he has all the technological skills to use any new communication techniques or devices. Because of his employment and the needs of his own family he does not have time enough to move to Coín to visit his mother as much as he would like. He thinks the system offered by the ExCITE project is very useful to help people who are in similar situations to him and his mother. In addition, he tries to convince his family to make use of the telepresence system because he believes it is worth to help his mother. However, the rest of his relatives are not as enthusiastic as he is and they are not so interested in the use of the system.

5.3.2 End User side

5.3.2.1 Psychological measures

The results of Geriatric Depression Scale (GDS) show scores substantially similar over time, indicative of the presence of mildly depressive symptoms (score between 10 and 19). Similarly, the scores on the perceived loneliness scale (UCLA) indicate an experience of severe loneliness (UCLA score > 40).
The feeling of loneliness is also reflected in perceived social support. The initial total score (S0) of the Multidimensional Scale of Perceived Social Support Scale (MSPSS) is 32 (range score 12-84; the higher the score the higher the perceived social support). Similarly, the scores in the three subscales of MSPSS generally indicate a low perceived social support from both family network, both from friends and significant others (Figure 40)
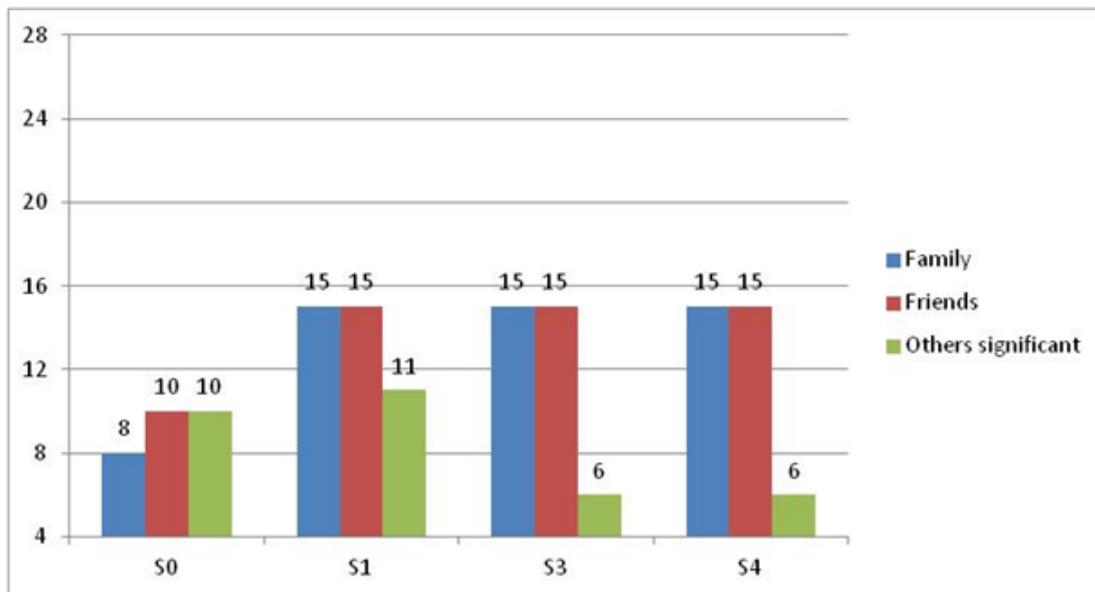
Figure 40: Total scores for each dimensions of MSPSS obtained from the sum of the responses from the items in each of the three dimensions (range score 4-28).

The score of the Short Form-12 Health Survey (SF-12) show low mean meta scores of the Physical Component Summary (M=23.4) indicating a poor quality of physical health status characterized by substantial limitations in social and personal care activities.

5.3.2.2 Robot Acceptance

The analysis of social and functional acceptance over time show that at S0 end user's Intention of Use (ITU), Perceived Usefulness (PU), Perceived Enjoyment (PENJ) and Social Influence (SI) are moderate as well as the positive feelings about the appliance of the robot (ATT). Facilitating Conditions (FC), Perceived Enjoyment (PENJ). Perceived Adaptiveness (PAD) and Perceived Ease of Use (PEOU) indicate respectively a high perception of factors in the environment that facilitate use of the system and of adaptability of telepresence robot to the needs of the user associate with feelings of pleasure associated with the use of the robot. End user's Trust toward functionalities and reliability of the telepresence system is very high (Figure 41)

As shown in Figure 41 over time end user's Intention of Use (ITU) and Perceived Usefulness (PU) increase slightly compared to the other factors that instead remain similar and indicative of a substantial acceptance of the robot.
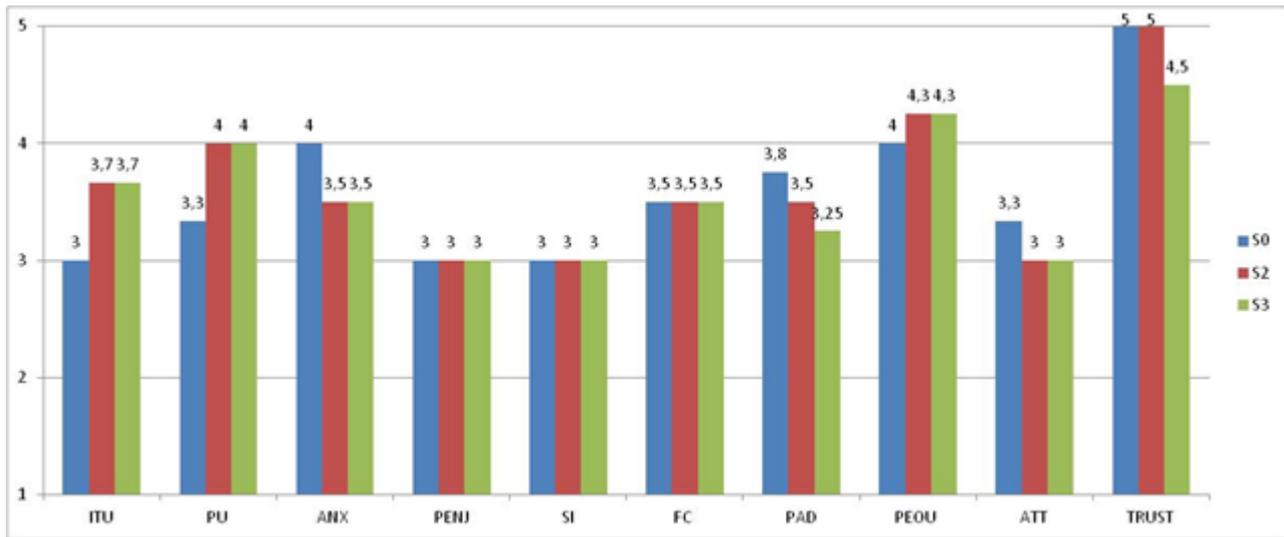
Figure 41: Mean scores for each Almere Model constructs
(5 points Likert scale, from 1= completely disagree to 5= completely agree)

5.3.2.3 Attitude and affective response toward the robot

Even thought the end user recognize somewhat the benefits and advantages related to the everyday use of the robot (M=2,4) showing also a moderate satisfaction with the Giraff's functionalities and features (M=2,4), he perceives the presence of the robot as a sensible intrusion into his domestic privacy (M=2) and apprehension for management difficulties (M=2.4). In addition a slight psychological distance between himself and the adopted robotic aid (M=1.4) is reported. (Figure 42).
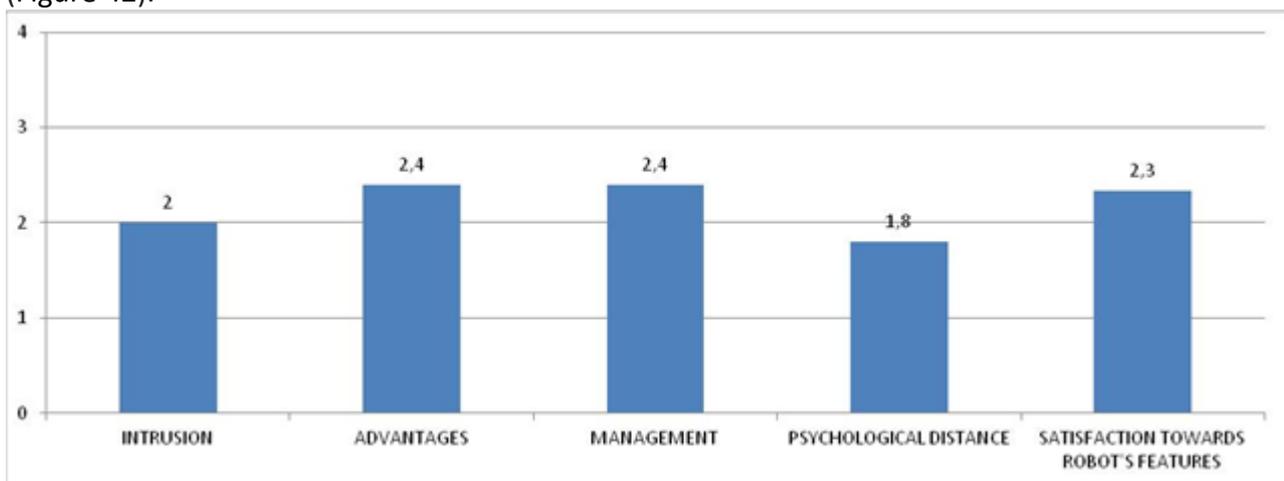
Figure 42: Mean scores for each dimension
(5 points Likert scale, from 0= completely disagree to 4= completely agree)

The end users reported a moderately positive affective response toward the use experience with the telepresence robot. Specifically, the score of subscales on PANAS scale was respectively 30 for Positive Affects and 14 for Negative Aspects. This positive affective reaction leads the end user to perceive the robot as very interesting, reassuring, fascinating and moderately useful. However

some negative affective responses emerge describing the robot as moderately cumbersome, worrisome and dangerous.

5.3.2.4 Telepresence dimensions

The end user has a good experience during the interaction mediate through the robot in terms of subjective experience of warmth and intimacy in the mediated interaction (**Social Richness**) and psychological connection to and with another person (**Co-presence**). Nevertheless, the perception of pleasantness during the robot usage (**Perceived Enjoyment**) and of being together (**Social Presence**) the secondary user during the mediated interaction is very low (Figure 43)
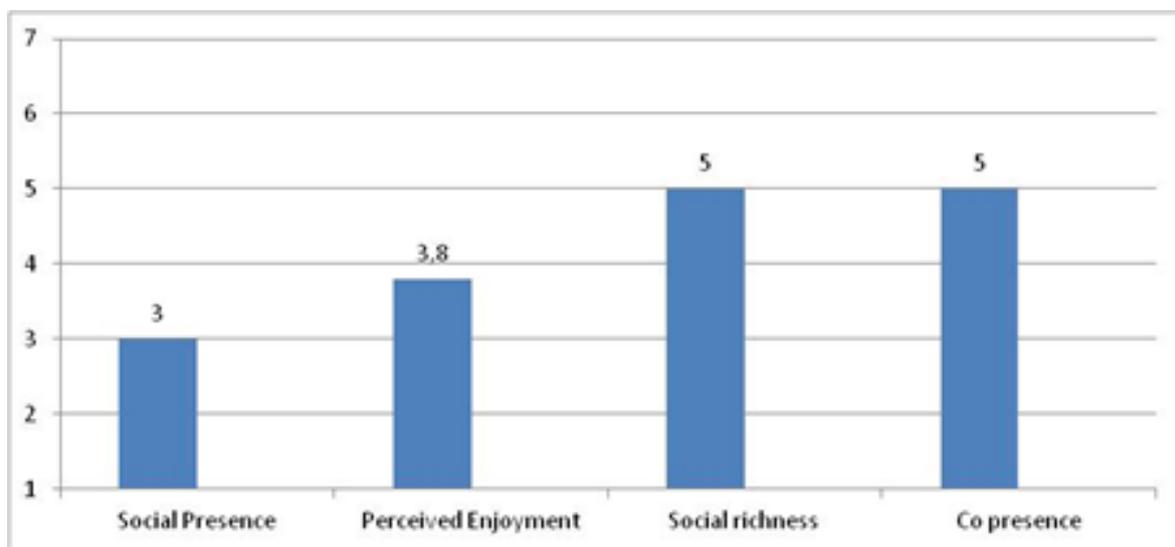
Figure 43: : Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

5.3.2.5 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

The robot did not have a tangible psychosocial impact on end user's everyday life (Figure 44) Comparing the scores of the three subscales of the PIADS questionnaires it is possible to note minimum and partial improvements in terms of Competence (M=0.6), Self Esteem (M=0.6) and Adaptability (M=0.7).

In terms of Competence the use experience with the robot has a positive and substantial impact in capacity of handling life situations (Adequacy) and in feeling competent (Capability). Slight increases emerge in Performance, Expertise and Usefulness.

Similarly respect to the Self Esteem, the use of the robot has increased Sense of Control, Self Confidence, Security and Happiness. In addition, Ability to adapt to the activities of daily living, Ability to participate, Willingness to take chances and Well being are positively affected by the use of robot.
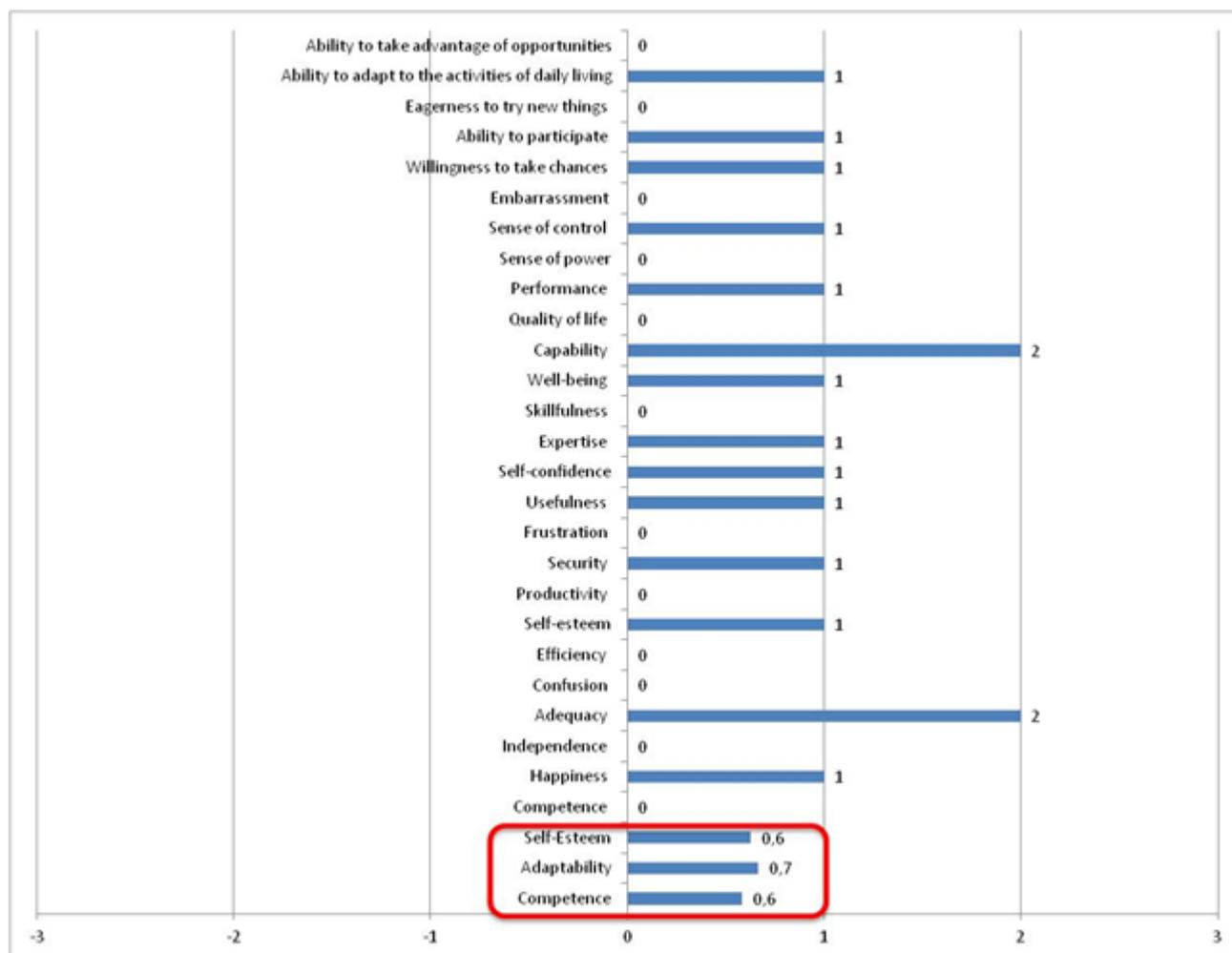
Figure 44: Mean score on three sub scale of Piads distribution of end user response.
Scale from -3 [Decreases] to + 3 [Increases]

5.3.3 Pilot side

5.3.3.1 Expectations toward the telepresence system

Most of secondary user's expectations, related to the use of the telepresence system as a means to support an older adults and to foster own social interaction, are generally confirmed over phases of evaluation (Figure 45).
At the beginning of the experience the secondary user expects that a telepresence system may be a slight threat to the domestic privacy of an older end user or may be negative for human relationship.
He hesitates about the possibility to have more stable and frequent contact using telepresence system or to feel closer with the end user. The client has a moderate expectation related to these potential functions of the system.
In addition, the secondary user assume that the system can moderately to be a support communication and a manner to decrease the physical visits. He also does not believe that the use of the system can alleviate the older user's sense of loneliness.

During the use experience with the system (S2) it is interesting to note that the secondary user's changes his mind about some of the initial expectations. In particular, he affirms the high possibility to have more stable and frequent contact using telepresence system, to feel closer with the end user and the effective value of the system as support for communication. In this phase, the secondary user believes that the use of the telepresence system can a lot alleviate the older user's sense of loneliness.

These expectations are confirmed in the S4 when the robot is removed from the end user's apartment. Specifically, in this phase the secondary user affirms that not using the telepresence system he has far fewer stable and frequent contacts with end user perceiving a considerable lack of support for everyday communication and a sense of distance to end user. In addition, he believes that the absence of robot may contribute enough to increase loneliness of end user at home.
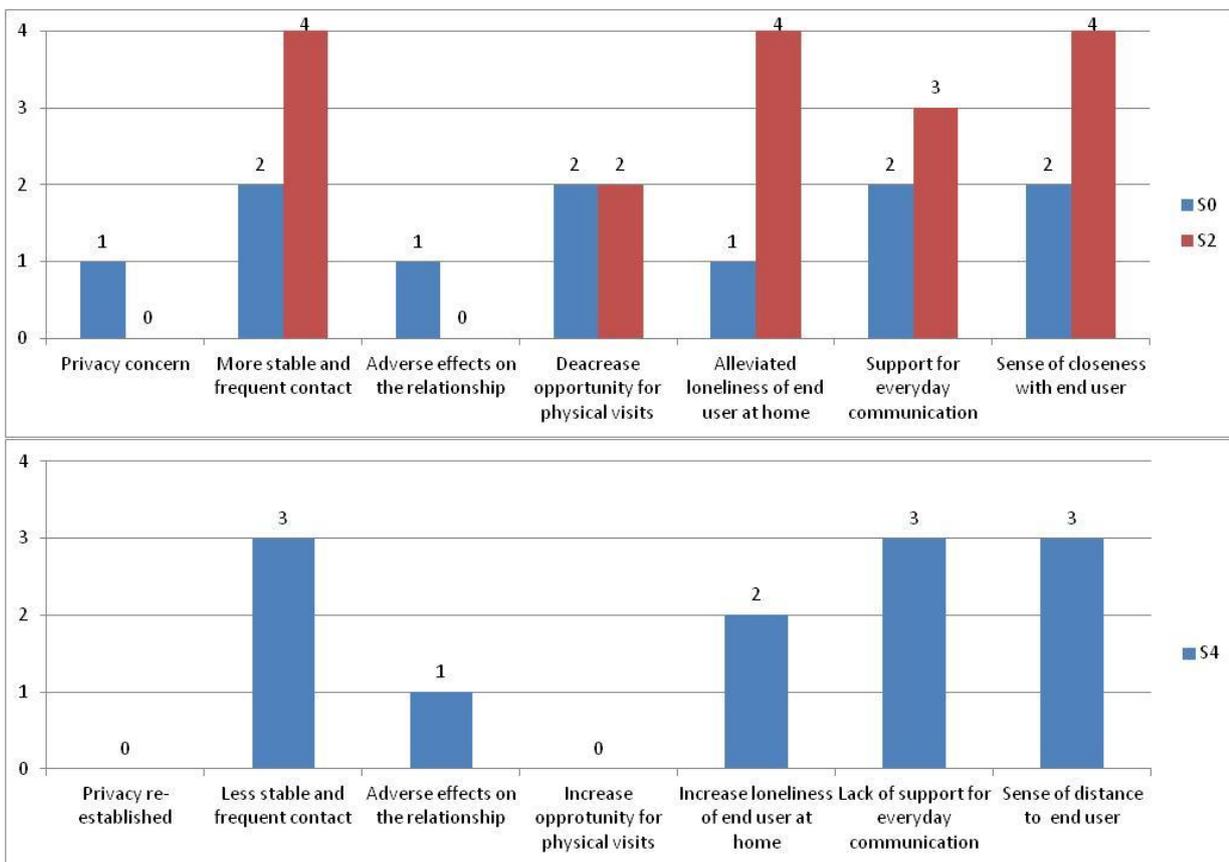
Figure 45: Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system (5 point Likert scale from 0=not at all to 4=very much)

5.3.3.2 Usability Scale - Ease/Difficulty of learning and use functions' and commands' interface

The analysis of the SUS questionnaire showed a score of 72,5 indicating a good level of subjective usability of the Giraff's client interface. However, the time trend of the ease of use of specific functionalities show a partially good level of usability (total mean from M=2,3 at S1 to M=2.6 at S2) highlighting some issues related to the functions of docking (docking, position for docking and

check the docking status), the audio and video quality of the interface and the management of the volume of audio outbound and incoming. The usability of these functionalities gets worse over time or maintaining an unsatisfactory score. (Figure 46)
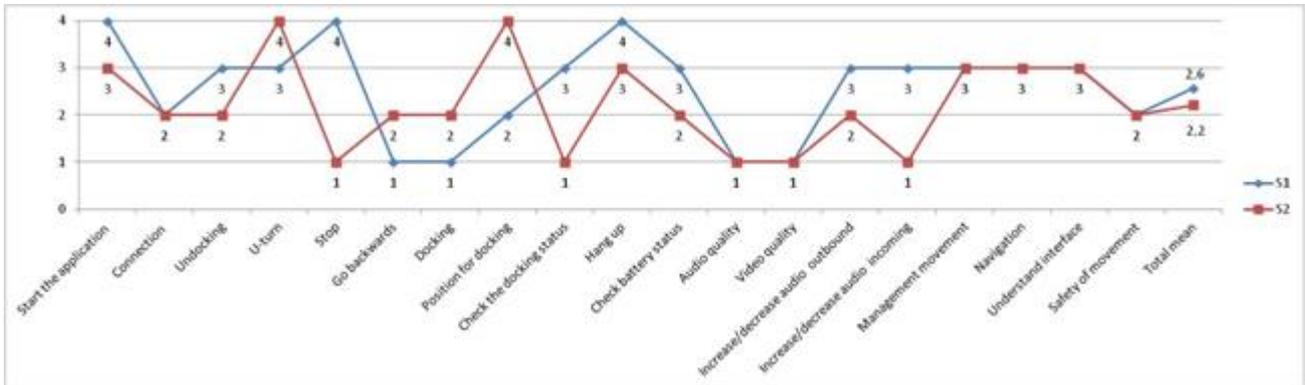
Figure 46: Questionnaire distribution on pilot response to usability assessment
(5 points Likert scale from 0 = very difficult, 4 = very easy)

5.3.3.3 Telepresence dimensions

As shown Figure 47, the secondary user experiences minimally a sense of **Spatial presence** (sense of being physically located in a virtual environment). Contrary the perception of **Social Presence** (feeling of being together) is very strong.

He reports satisfactory degrees of **Co-presence** (psychological connection to and with another person), Perceived psychological engagement (extent to which the user feel mentally immersed in the experience) and **Perceptual Realism** (experience in which the mediated interaction accurately simulates or reproduces the sensory experience that would be expected in the non-mediated interaction).

Perceived behavioral interdependence (extent to which a user's behavior affects and is affected by the interacting behavior) and **Social richness** (subjective experience of warmth and intimacy in the mediated interaction) are well perceived.
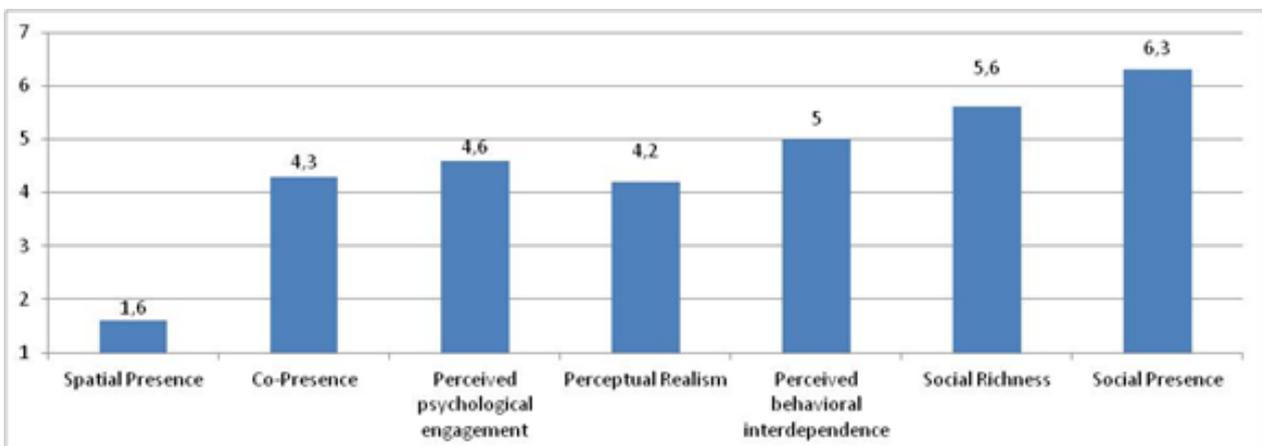
Figure 47: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

5.3.3.4 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

Analysis on the PIADS scale reveals that overall the service offered through Giraff telepresence system did not have a particularly strong psychosocial impact on the secondary user's life, not causing any remarkable changes (Figure 48).

From the point of view of the three sub-scales of the PIADS it is possible to say that a minimum improvement has been obtained especially with respect to **Competence** (M=0.8) with a considerable increase in Productivity and Efficiency. Slights increases is possible to note also in Performance, Quality of life, Usefulness and Independence.

Very slight changes are obtained in terms of **Self-esteem** (M=0.5) and **Adaptabilit**y (M=0.5).

Referring to Self-Esteem, the use experience with the telepresence system respectively has a small positive impact in Sense of Control, Security, Self Esteem and Happiness.

In terms of Adaptability, the use of the system has increased the Ability to adapt to the activities of daily living, Eagerness to try new things and Ability to participate.
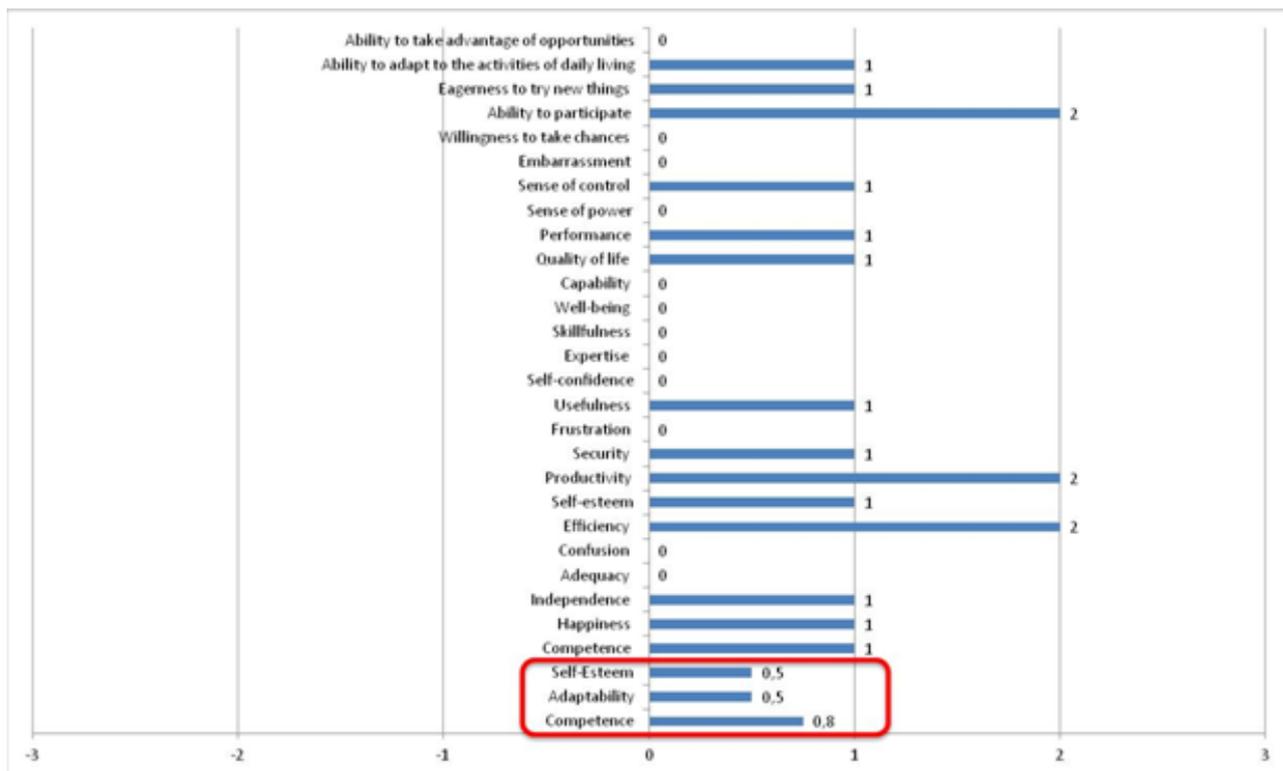
Figure 48: Mean score on three sub scale of Piads distribution of end user response.
Scale from -3 [Decreases] to + 3 [Increases]

5.3.3.5 Affective state related to the use experience and interaction through telepresence system: PANAS scale

Positive affect subscale show higher scores (31) than Negative Affect subscale (11) and this result indicate that end experiences a pleasurable engagement with the technology.

5.4   Discussion on Spanish Test Sites

The Spanish test site involved 3 older end users, including two females (**65yr F** [Test Site 1] and **F 77yr** [Test Site 3]) and one male (**M 80yr** [Test Site 2]).
Two clients belonging to the family network of end users **65yr F** and **F 77yr** and 1 client as a professional caregiver participated in the project's user evaluation.

The experience of long-term use of the telepresence system Giraff has been quite encouraging for all the test sites in terms of *attitude*, *affective response*, *robot acceptance*, *psychosocial impact*, *usability* and dimensions of *telepresence*.

Below we provide an overall interpretation of the results and differences related to the dimensions investigated and obtained from the point of view of the end users and clients as protagonists of these three test sites .

End user side

Perceived social support: Although the perceived social support is always to be read within the context of the life of the individual, in this circumstance it is sufficient to note that generally the family represents and remains the primary source of perceived social support over time especially for **65yr F** [Test Site 1] and **M 80yr** [Test Site 2]. These two end users seem to perceive a sufficient social support also by other significant persons, while their friendship network is inclined to be rather limited.
F 77yr [Test Site 3] perceives a more moderate social support from family respect to others end users. Similar perception is also refer to friendship network. The perceived social support by other significant persons is more limited.

Attitude and affective response towards the robot: Overall, the end users' attitude towards the robot is rather positive in terms of benefits and advantages of the Giraff robot related to their needs and of satisfaction toward the robot's features. End users have a tendency not to feel a psychological distance between them and the robot, but they are uncertain about the concrete level of intrusion of the robotic device into their private home life. A slight apprehension for management difficulties related to the use of the robot at home emerges in all the end users.

The affective response is positive for all end users showing a pleasant experience and engagement in the long-term use of the robot.

Robot Acceptance: overall, the end users' level of functional and social acceptance of the robot is rather constant and high over time.
All end users are fully convinced that the robot performs with personal integrity and reliability (TRUST). There is a tendency to perceive a good ease of use (PEOU) and usefulness (PU). The end

users well perceive that people who are important to them think he/she should or should not use the robot (SI). Factors in the environment that facilitate use of the robot (FC) are clearly perceived. End users are more uncertain in judging their intention to use the robot over a longer period in time (ITU), the pleasantness of their feelings of joy associated with the use of the robot (PENJ), the concrete ability of the robotic system to adapt to the everyday life needs (PAD) and their attitude toward the daily use of the robot (ATT). The usage of the robot generally evokes slight anxious reactions (ANX).

Psychosocial impact of the robot on the end user's quality of life: considering the end users' perspective the use of the Giraff robot did not have a tangible psychosocial impact on their everyday life. End users reported very slight improvements in terms of impact on self-confidence, self-esteem and emotional well being (Self-Esteem subscale of PIADS), of effects of the robot on functional independence, performance and productivity (Competence subscale of PIADS) and of willingness to try new experiences and feeling of well-being perceived in relation to the use of robot (Adapatability subscale of PIADS).

Telepresence dimensions: all the end users' have a good subjective experience of warmth and intimacy in the mediated interaction through the robot (Social Richness) and a rather strong feeling of psychological connection to and with another person (Co presence).
Feeling of being together (Social Presence) and of enjoy during the robot usage (Perceived Enjoyment) are less perceived among the Spanish end users.

Client side
Expectation toward the telepresence system Giraff: referring to the expectation of relative client users without special caregiving responsibility (Client 1 and Client 3), the long-term experience confirm or reinforce the individual expectations toward the telepresence system Giraff as a means to support an older adults at home and to foster social interaction. Overall, the telepresence robotic system Giraff represents an added value for the client users as an aid to:

- have stable and frequent contacts with end user;
- support everyday communication;
- feel closer the client with the end user;
- to alleviate end user's perception of loneliness at home.

From the point of view of Client 2 as a professional caregiver, this secondary user doesn't perceive the telepresence system Giraff as an effective support for the older user's time management, for alleviating the end user's need for home help service and for more stable and frequent contact with the end user at home. The system is not also a source of reassurance for the client in his own role of professional caregiver.
Nevertheless, the potential validity of the system for remote assistance service and for the management of any unexpected events is highly recognized.
Common to all involved client users of the Spanish test sites is the idea that the telepresence robotic system is not a threat to the privacy of an older end user at home and its functionality do not have adverse effect on human relationship.

Usability of the system's interface: the level of subjective usability is good enough for all clients. This result is also confirmed by the questionnaire on the usability of the system we developed ad hoc, which individuates also some critical aspects of the usage for specific functions and commands.

Functionalities and commands relative to docking, position for docking and check the docking status, have an uncertain ease of use over time in all client users' experience.
In addition, quality and efficiency of audio and video functions are assessed also as doubtful in terms of ease of use of the system.

Overall, it is possible to affirm that using the system for long period of time had generally a positive impact on the usability of the telepresence system.

Psychosocial impact of the robot on the end user's quality of life and affective response: The use of the telepresence system has had an impact that shows some slightly discrepancies between the experiences of the three client users.

The service offered through the Giraff telepresence system had a more tangible strong psychosocial impact on the everyday life of Client 1 and Client 2 life. From the Client 3 point of view, the telepresence system did not have a particularly strong psychosocial impact on his life, not causing remarkable changes.

Overall, it is possible to highlight that it is common to all involved client users of Spanish test sites a more concrete impact of the telepresence device on individual functional independence, performance and productivity (Competence subscale of the PIADS).

In terms of affective response, all the clients experienced a very pleasurable engagement in terms of positive affects during the long-term use experience.

Telepresence dimensions: Common to all involved client users of Spanish test sites is the difficulty to clearly perceive the sense of being physically located in a virtual environment (Spatial Presence). All client users are very satisfied in their feeling of mentally immersion in the telepresence experience (Perceived psychological engagement) and of feeling of being together (Social Presence) with the end user during the mediated interaction. In addition, subjective experience of warmth and intimacy in the mediated Interaction (Social Richness) is highly perceived in all client users.
Client 1 and Client 2 have a more high perception of psychological connection to and with another person (Co presence) through the telepresence system than Client 3.
Client 1 and Client 3 are more uncertain than Client 2 respect to the accuracy of sensory experience in the mediated interaction through the telepresence system (Perceptual realism).
Client 1 user perceived more the extent to which a user's behavior affects and is affected by the interactant's behavior (Perceived behavioral interdependence) respect to others client.

6   ITALY Test Sites Results

In this section we provide a summary of the main results gathered from each test site in Italy. Specifically we report the feedback obtained from the successfully ended test sites.

6.1   Test site Italy 1

The entire long-term experience lasted 1 year, from January 2012 to January 2013.

6.1.1 Participants

End Users: The long-term experiment involves a couple of old adults as end users of the telepresence robot. The woman (*end user* **F**) is 84 years old with primary education. She has problems with her sight; she has no experience with technology in general, apart the television, and never uses computer in everyday life. The man is 86 years old (*end user* **M)** with primary education. He has reduced mobility and, like his wife, never uses technology in everyday life apart the television. They are quite independent although their health condition is slowly deteriorating. They live in a country near Rome and spend all the time in their home having difficulties in going outside. Their social network with the external world is rather limited and they have agreed to take part in the user evaluation motivated by the fact that they can have more possibility of visual contact with their only son, who represents the user pilot.

Pilot User: 55 years man who lives in Rome (25 Km far from his parents) and visits them on a regular basis (usually once-twice a week). He has a high experience with technology in general using most of the technological devices daily both at work and for personal reasons. The pilot user expresses some concern for the frail health status of his parents and he willingly accepts to take part in the case study, he also motivated by the fact that he can have more chance of eye contact with his parents and more control over their physical and health conditions.

6.1.2 End User side

6.1.2.1 Robot Acceptance

Mean scores of selected constructs of the Almere model have been calculated to access the level of acceptance of the robot on behalf of two end users (Figure 49 and Figure 50)
At time S0 it is possible to note the high perceived level of anxiety (ANX) of end user **F** (*M*=5), compared to the end user **M** (*M* =3) toward the use of the robot. The anxiety perceived decreases over time for both users, but for the end user **F** remains highly perceived (*M* (S3) = 4) compared to the end user **M** (*M* (S3)= 2).

The initial end user's **F** attitude (ATT) toward Giraff robot is rather neutral (*M*(S0)=3) , but over time it becomes very positive (*M*(S3=4). During S0, the end user **M** immediately reveals a positive attitude that is confirmed over following steps.
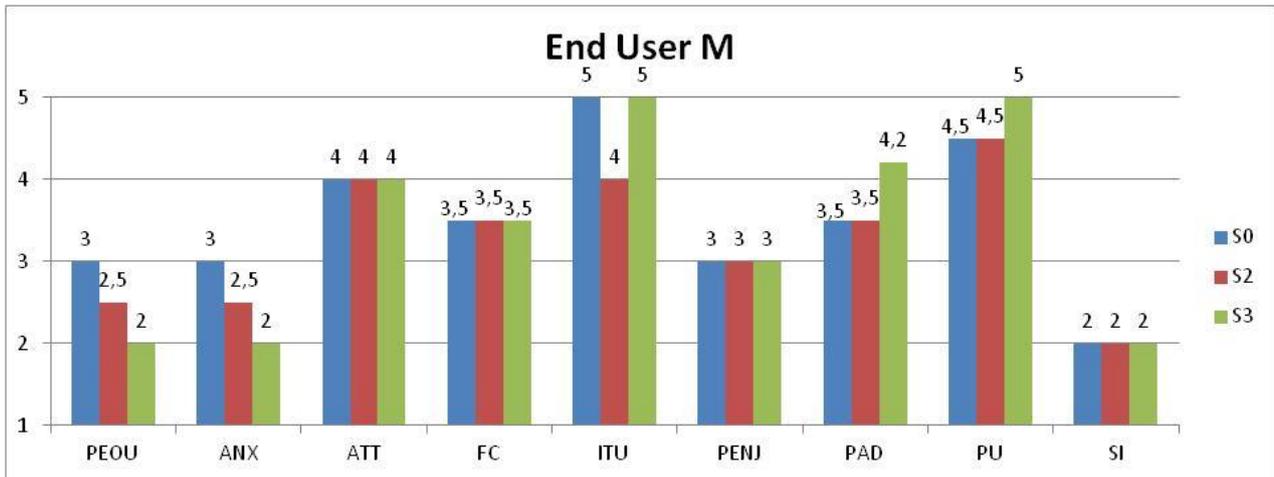
Figure 49: End User M mean scores for each Almere Model constructs
(5 points Likert scale, from 1= completely disagree to 5= completely agree)
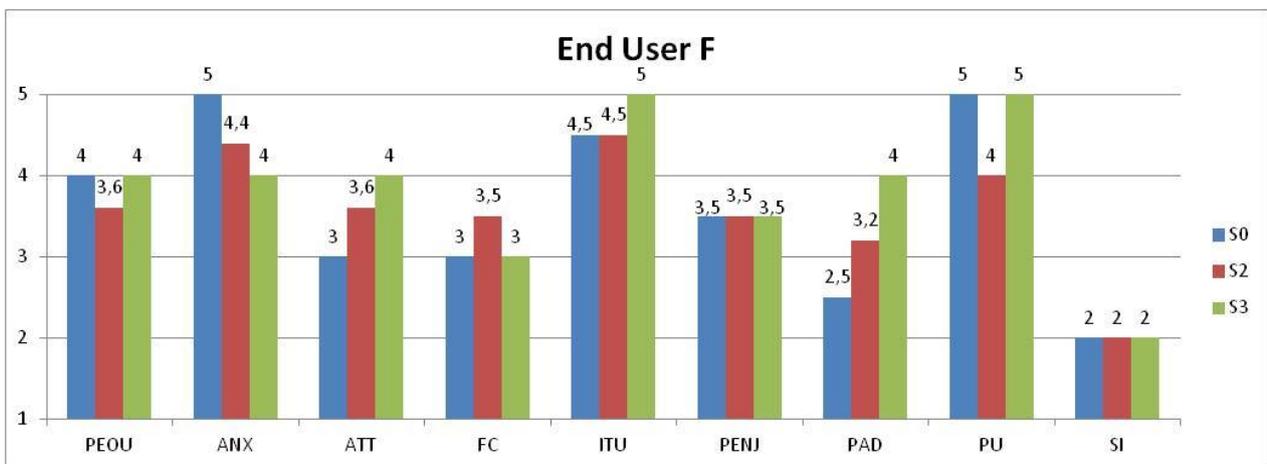
Figure 50: End User F mean scores for each Almere Model constructs
(5 points Likert scale, from 1= completely disagree to 5= completely agree)

The **F** end user's Perceived Ease of Use (PEOU) remains high over time, while for the end user **M** it decreases noticeably during the use experience.
The Intention to Use (ITU) the system for a long period of time, the Perceived Usefulness (PU) and the robot's ability to adapt to the needs of the user (PAD) increase over time, following a similar trend for both the end users.
The perception of environmental factors that facilitate the use of Giraff robot (FC) is doubtful for both users and especially for the end user **F** that show slightly decreased scores over time.

End users' Perceived Enjoyment (PENJ) remains uncertain during the all steps of evaluation. Finally, neither of the end users perceive that other people that people who are important to them think they should or not should use the robot.

6.1.2.2 Attitude and affective response toward the robot

Figure 51 shows the mean scores of the dimensions of the attitude of the end user toward the telepresence robot.
For both end users, the robot is not perceived as an element of intrusion into their home life, even if this perception goes through a slight increase in the step S3 remaining at a low level.
The advantages of the use and the presence of robot at home are appreciated and recognized over time.
There is a good satisfaction about the robot's functionalities. The end users do not have an attitude of distrust (in terms of psychological distance) toward the Giraff robot.
Finally there is a difference between the end user **F** and the end user **M** regarding the difficulties management and maintenance of the robot which increase over time for the end user F.
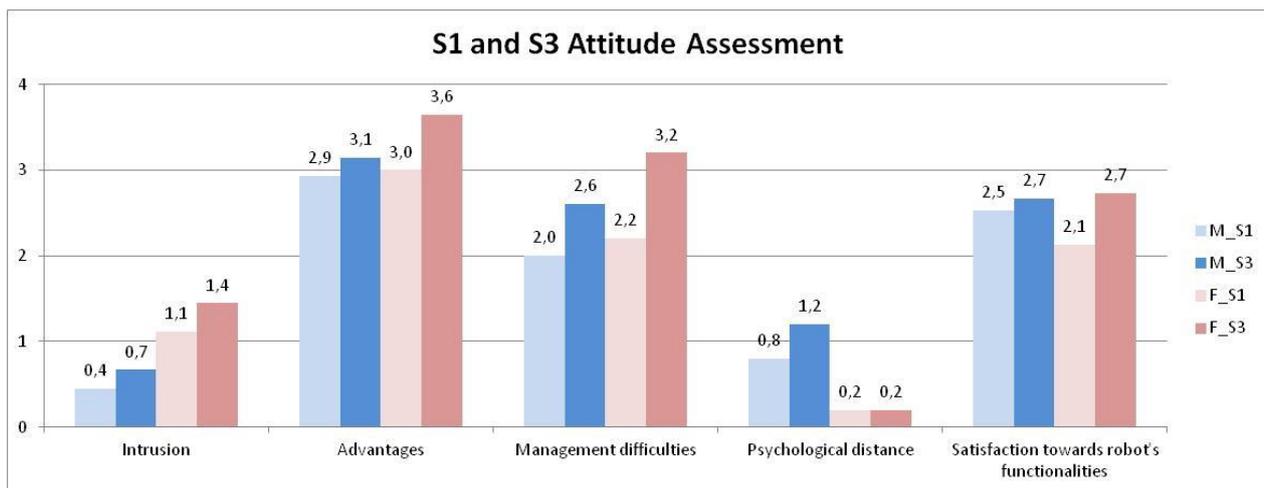
Figure 51: Mean scores end user M and F
(5 points Likert scale, from 0= completely disagree to 4= completely agree)

The end users reported a rather positive affective response towards their experience with the telepresence robot. The scores obtained respectively for the PA subscale (positive affect) and NA (negative affect) from the end user **M** is 38 *vs.* 21, while for the end user **F** is 41 *vs.* 19.
In addition, the emotional reaction measured by the affective scale of our Attitude Acceptance questionnaire, showed that primary users affectively responded in a very similar way to the robot. Specifically, a high scoring was found on the positive adjectives fun, interesting, useful, stimulating and reassuring.

6.1.2.3 Telepresence dimensions

The quality of interaction (Figure 52) mediated thorough the robot in terms of Social Richness is considered satisfactory by both end users. They have a subjective experience of warmth and

intimacy during the mediated Interaction with the pilot user. Less satisfactory is the perception of Social Presence (in terms of the feeling of being together with the pilot user), Co presence (in terms of psychological connection to and with another person) and Perceived Psychological En
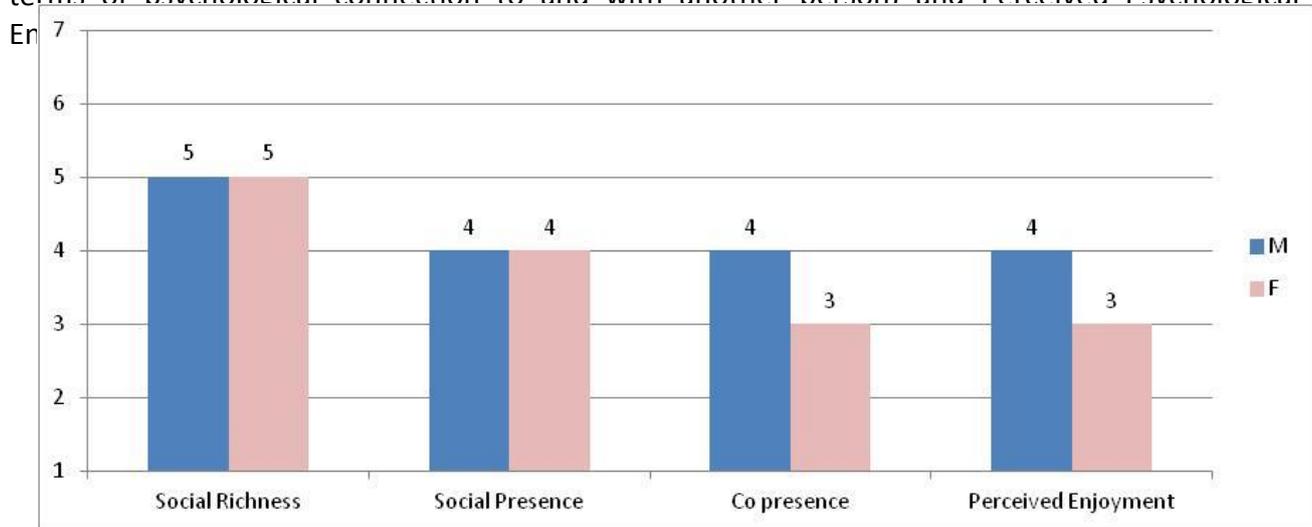
Figure 52: Mean scores of telepresence dimensions for end users (M and F)
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

6.1.2.4 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

End user **M**: using the telepresence robot has impacted positively in person's daily life in terms of **Adaptability** (M=1.5), increasing Well-being, the Ability to participate, Eagerness to try new things and Ability to adapt to the activities of daily living. A slight improvement is also in **Self Esteem** (M=0.7) and specifically in the sense of Security and Self-confidence. No significant improvement in terms of **Competence** (M=0.6) although Usefulness and Quality of life increase. (Figure 53)
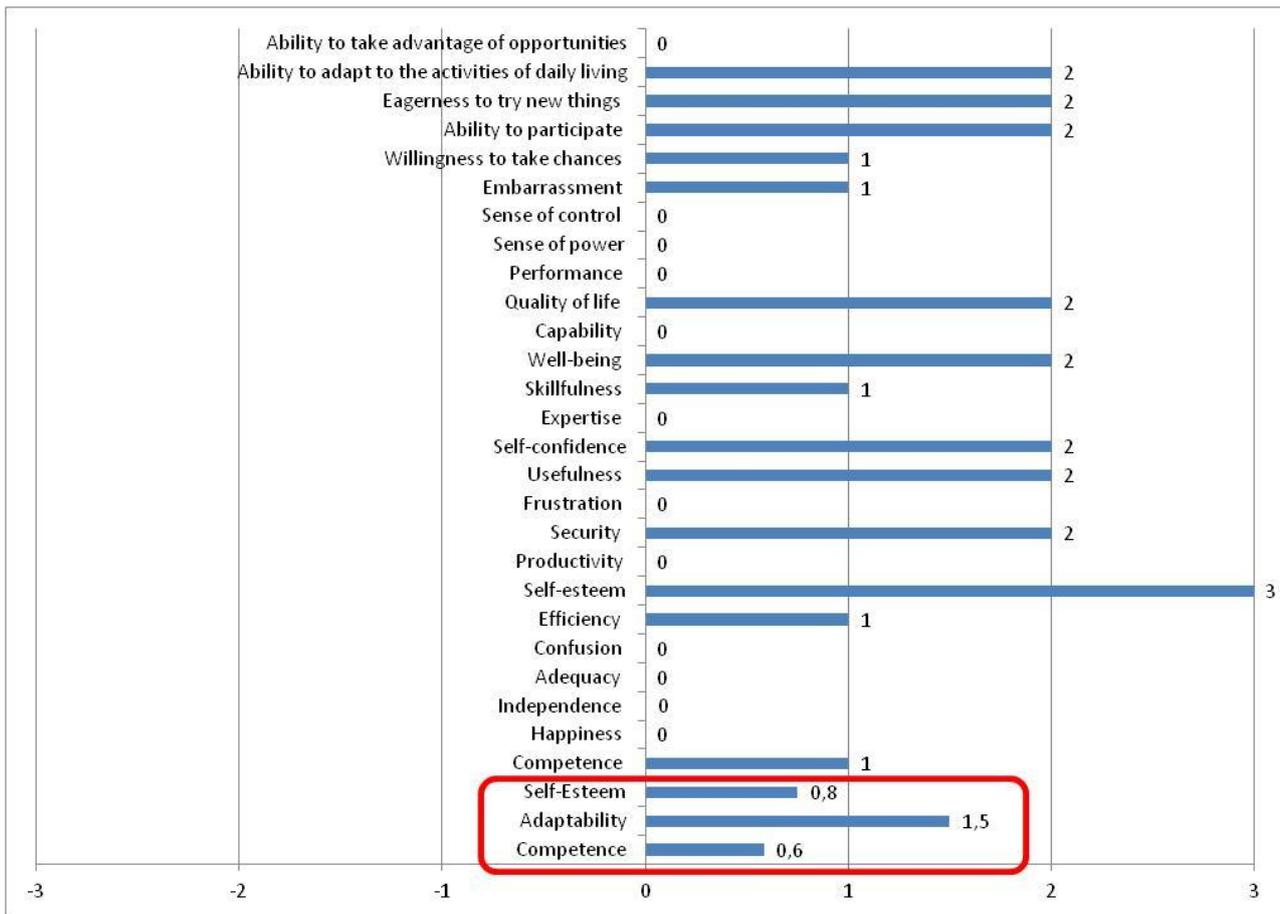
Figure 53: Mean score on three sub scale of Piads distribution of end user **M** response.
Scale from -3 [Decreases] to + 3 [Increases]

End user **F**: The use experience with the Giraff robot at home has not had a significant psychosocial impact on quality of life of this user. Comparing the scores of the three subscales of the PIADS it is possible to note that a small improvement was achieved mainly in terms of **Self-Esteem** (M=1), with an increased Self Confidence and Security. The use of the robot does not seem to have had a influential impact in terms of **Competence** (M = .83), however, it is possible to note a very positive influence on the sense of Independence and Adequacy. No real improvement in terms of **Adaptability** (M=.33) (Figure 54)
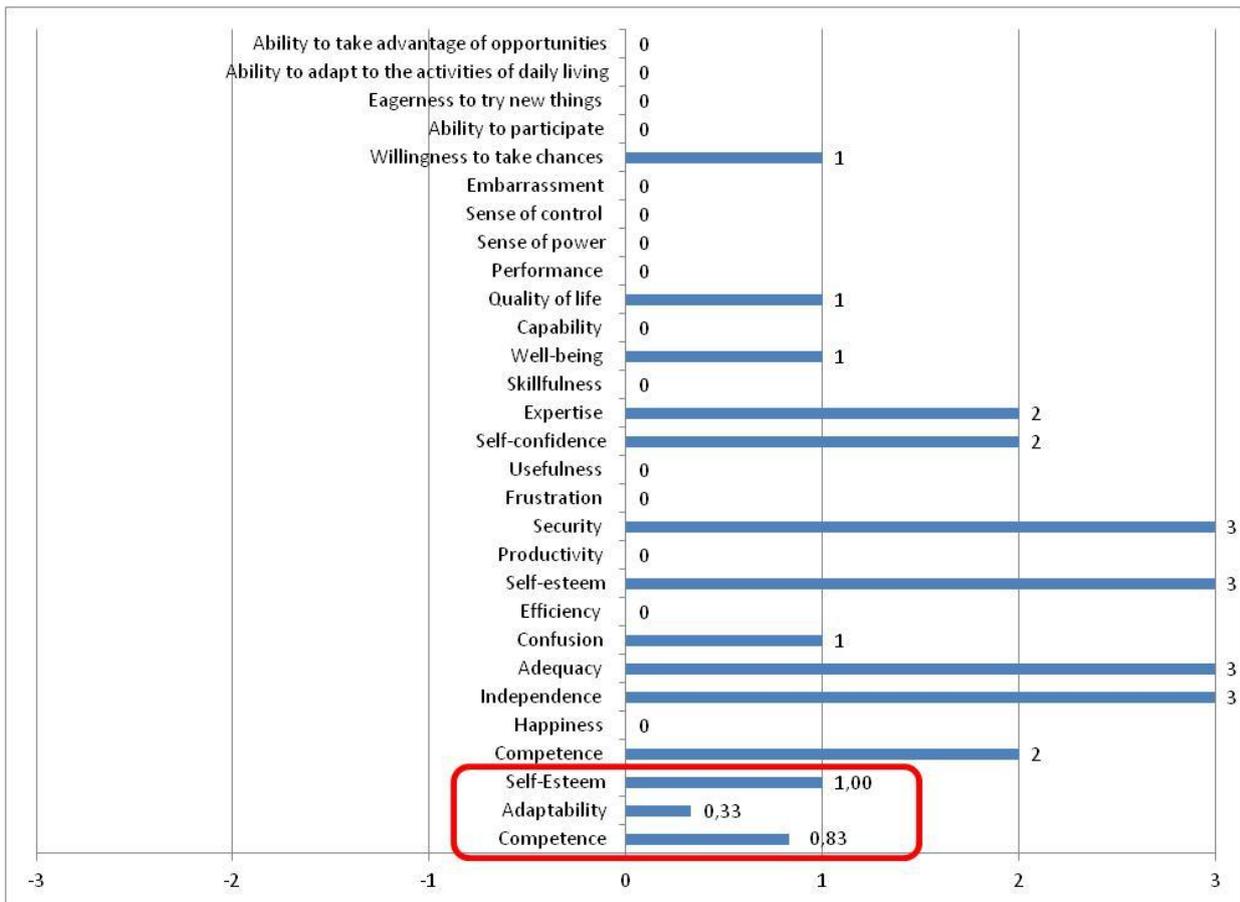
Figure 54: Mean score on three sub scale of Piads distribution of end user F response.
Scale from -3 [Decreases] to + 3 [Increases]

6.1.3 Pilot side

6.1.3.1 Expectations toward the telepresence system

At time S0, the pilot user is concerned that the telepresence system may be perceived as an element of intrusion in the domestic privacy by his parents and that they might have trouble getting used to interact with the robot. However, the pilot user imagines that Giraff may be a support for his caregiving role and an element of reassurance for him in the remote management of his parents. The usage of telepresence system also is a means to alleviate the need of pilot's presence at his parents' home for overseeing certain activities of daily living.

In addition, the telepresence system may provide more stable and frequent contacts between the pilot user and the end users. The user does not believe that the use of the system may have a adverse effects on their relationship nor on the opportunities for physically visits. Giraff telepresence system is not recognized initially as a means to alleviate end users' reliance on the pilot user and to handle unexpected events.

The use experience with the telepresence system (S2) reduces the user's initial concern for intrusion in the domestic privacy of the end users and for their difficulty to get used to interact with the robot. Giraff system proves to be a valuable means in the remote management of end users in terms of reassurance and of a pilot's slighter apprehension to be more present at end users' home. This confirms the initial expectation towards the system as a means to have more stable and frequent contacts with the parents. The pilot user recognizes that the system may also effectively to help in handling unexpected events. (Figure 55).

Figure 55: SO-S2 Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system (5 point Likert scale from 0=not at all to 4=very much)

At time S4 after the removal of the robot from the end users' home, the objective was to find confirmation of the pilot expectations validated over time and to evaluate the effects following the disengagement from' daily use of the telepresence system. The graph in Figure 56 confirms the results obtained at S2 respect to the domestic privacy of end users.
End users have had difficulty getting used to the absence of Giraff as a means of communication with the pilot. The disengagement from the use of the system has had an effect on the pilot's of a lower sense of reassurance and of more:
• need to be present at end users' home for overseeing certain activities of daily living;
• reliance of the end users by physical pilot's presence ;
• difficulty in remote control of the parents.

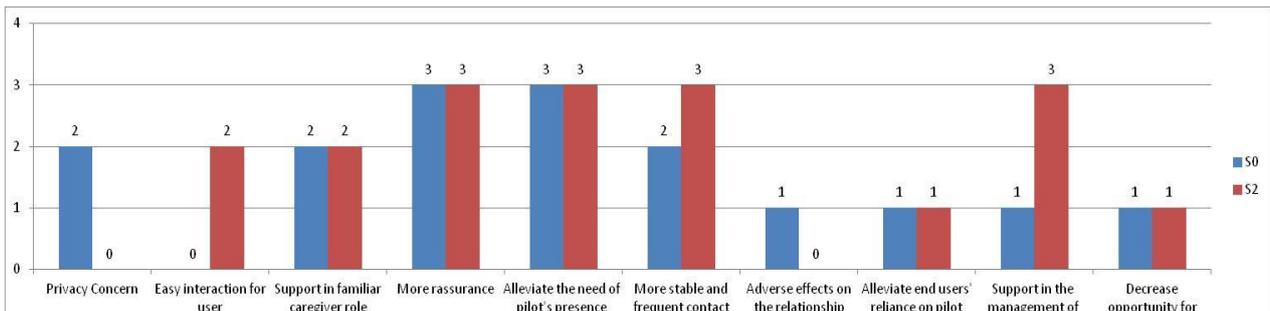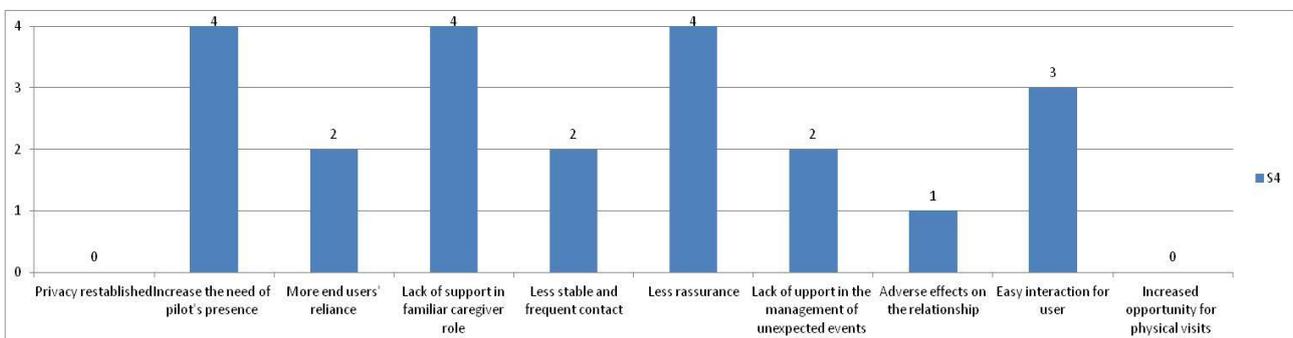**Figure 56: S4** Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system (5 point Likert scale from 0=not at all to 4=very much)

6.1.3.2 System Usability Scale - Ease/Difficulty of learning and use functions' and commands' interface

The SUS score indicates a low level of subjective usability (score = 52.5, range 0 to 100). This result is confirmed also by the questionnaire on the usability of the system we developed ad hoc for the case study (Figure 51). In general there is an increase of learning and ease of use of the interface between S1 and S2 (MS1 = 1.47 vs. MS2= 2.26), even though some commands and functions remain difficult to manage.

Figure 57 shows that initially understanding how to docking, to place the robot for docking and to check the level of docking. In addition at time S1, the pilot user considers difficult (score = 1) understand the interface as a whole and specifically to understand how to navigate through the environment, to manage the movement of the robotic platform and to adjust the volume of audio in and out. Video function, check battery status and hang up are also complex. All these functions and commands slightly improve their understanding and usability over time (see scores in S2).
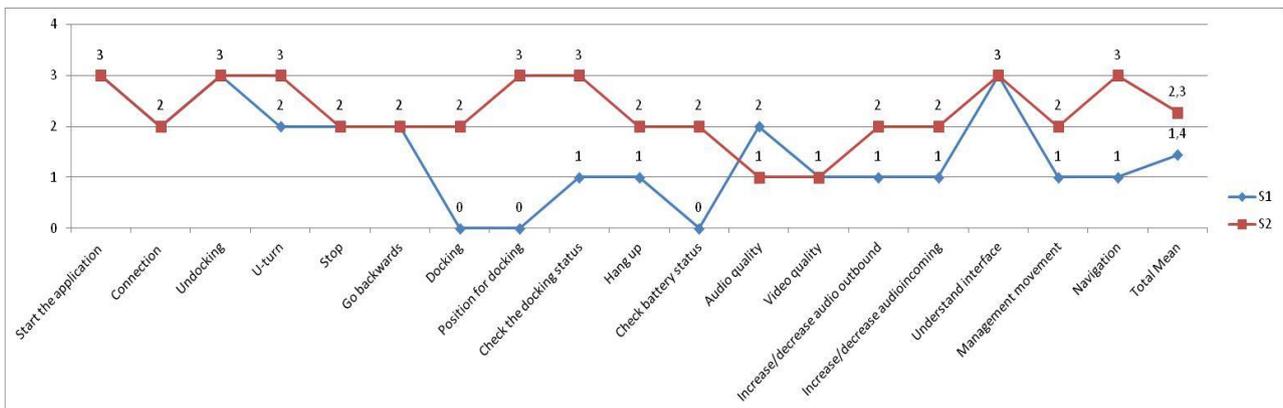
Figure 57: Questionnaire distribution on pilot response to usability assessment (5 points Likert scale from 0 = very difficult, 4 = very easy)

6.1.3.3 Telepresence dimensions

Regarding the telepresence dimensions (Figure 58) the pilot user perceives an insufficient level of Spatial presence (sense of being physically located in a virtual environment) and Co presence (psychological connection to and with another person). In addition, he has a moderate perception of Perceptual Realism (experience in which the mediated interaction accurately simulates or reproduces the sensory experience that would be expected in the non-mediated interaction), Social Presence (feeling of being together) and Perceived psychological engagement (extent to which the user feel mentally immersed in the experience). Nevertheless, the experiences of Social richness (subjective experience of warmth and intimacy in the mediated Interaction) and Perceived behavioral interdependence (extent to which a user's behavior affects and is affected by the interactant's behavior) are more satisfying.
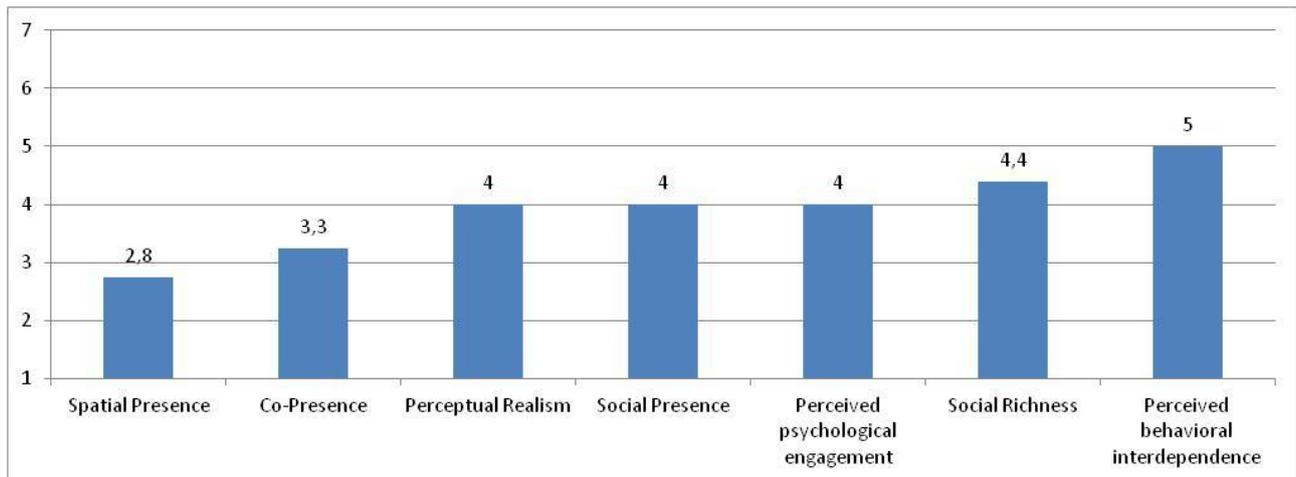
Figure 58: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

6.1.3.4 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

Analysis on the PIADS scale reveals that overall the service offered through the telepresence system did not have a particularly strong psychosocial impact on the pilot user's life. From the point of view of the three sub-scales of the PIADS it is possible to say that the main improvement has been obtained especially with respect to **Adaptability** (M=1,1) with a considerable increase in the Ability to participate and to adapt to the activities of daily living. Another small improvement was found in **Competence** (M=1). In particular, the aspects most improved in the life of the pilot user in relation to the use of the telepresence system regarding the Quality of life and the ability to:

- build on their knowledge by carrying out their tasks well (Expertise);
- manage the daily tasks efficiently (Efficiency);
- feel useful for themselves and others (Usefulness)
- be independent of someone or something (Independence).

The graph in Figure 59 highlight also a decrease in pilot's feelings to be able to get more things done in a day (Productivity).
The mean score obtained from subscale of Self Esteem is 0.8 and it is indicative of a poor impact of Giraff telepresence system in terms of change in the quality of life. Nevertheless it is possible to underlined the high scores obtained in Sense of control and Security (Figure 59).
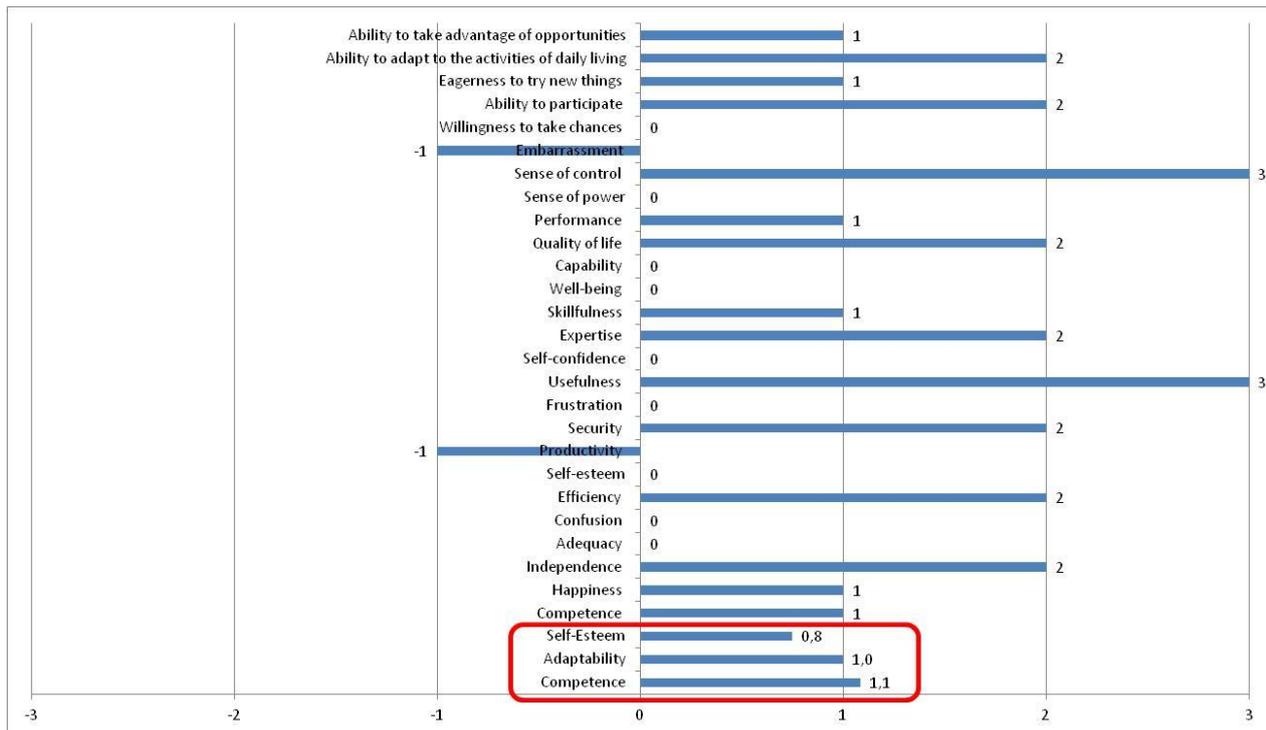
Figure 59: Mean score on three sub scale of Piads distribution of response.
Scale from -3 [Decreases] to + 3 [Increases]

6.1.3.5 Affective state related to the use experience and interaction through telepresence system: PANAS scale

The scores obtained respectively for the PA subscale (Positive Affects) and NA (Negative Affects) are respectively 29 *vs.* 21 and they are indicative of a doubtful emotional response compared to the experience of use with the telepresence system Giraff.

6.2 Test site Italy 3

The entire long-term experience lasted 1 year, from May 2012 to November 2013.

6.2.1 Participants

End User: 77-year-old woman with primary education. The end user has own home in Rome in which she has a self supporting life. Her apartment is on the first floor of a condominium and it is organized on a single level.
The end user has little knowledge of modern information and communication technologies. She has the use of a mobile phone to receive calls from family members when she is away from home. Because of cardiovascular disease and a history of depressive disorders, she follows several years a specific pharmacological therapy.
The end user has a reduced social network, sometimes she attends the neighborhood's senior center with two of her closest friends with whom occasionally spends time at home.

She has a very deep relationship with one of her two grandchildren. The relationship between the end user and his nephew represents the main motivation to take part in case study. The idea of being able to improve the daily contacts with her relatives adding a visual communication thorough the robot correspond to a need of this end user.

Pilot User: 24- years - end user's grandson with graduate education and a very good knowledge of modern information and communication technologies. Every day he makes use of the for reasons mainly related to the study and entertainment.

He lives in Rome and he has daily telephone contacts with the end user. Usually he meets her grandmother at least twice a week.

Initially, the end user's daughter is interested to interact remotely with her mother taking advantage of the robot. However, this pilot drops out of the case study at S0 because of some problems related to the possibility to have a stable wireless connection and internet access at her workspace and at home.

6.2.2 End User side

6.2.2.1 Psychological measures

At time S0, she experiences a rather severe loneliness (UCLA score = 55). Concerning the perception of her physical and mental health status, the score of the SF12 is indicative of psychological distress and social disability due to emotional and personal problems (Mental Component Summary - MCS=16.7). This aspect is also confirmed by the presence of severe depressive symptoms (GDS=25) that persist and remain stable over time.

The psychological distress subscale score, expressed by MCS component of the SF12, at time S3 increases (MCS=45.5) indicating a better perception of own mental health status by end user in relation also her use experience of the robot.

In the pre-adoption time (S0), the total score of the Multidimensional Scale of Perceived Social Support Scale (MSPSS) is 58 (range score 12-84; the higher the score the higher the perceived social support). In particular the three subscales scores indicate that the end user perceives a adequate social support from family, form friendships network and/or from significant other persons close to the user.

At time S1, a slight decrease emerge in the experience of loneliness (UCLA score=37). The same score is obtained at time S2.

Over time the family and friendships network remain relatively stable continuing to be the main source of perceived social support. However, during the end user's experience with the robot the perceived support from significant others persons noticeably increases. This score show a decrease at time S4. (Figure 60)
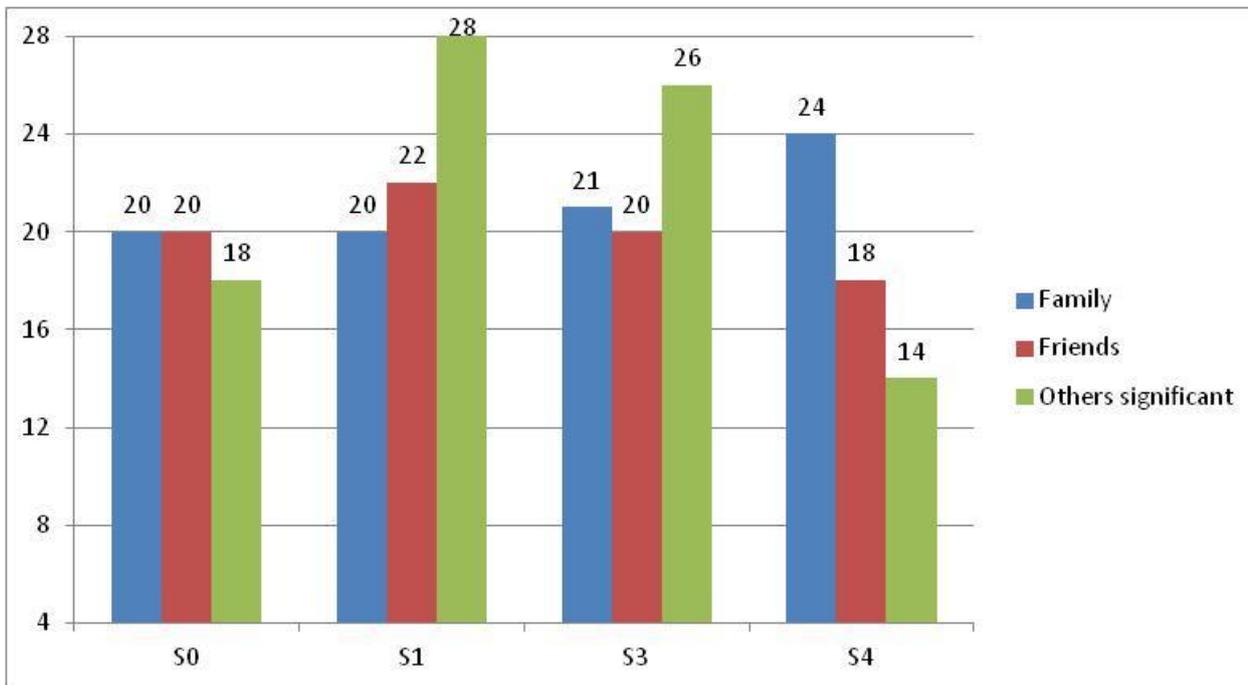
Figure 60: Total scores for each dimensions of MSPSS obtained from the sum of the responses from the items in each of the three dimensions (range score 4-28).

After five months from the closing of the case study and from the removal of the robot from the end user's home, the data collected at time S4 are indicative of a change in the scores related to the perception of loneliness and of social support . Compared to the previous evaluation steps, the end user show a slight increase in the perception of loneliness (UCLA score=47) and a lower perceived social support from significant others persons . Social support perceived from family and friendship remain rather stable.

It is important to underline that the data collected in this time may have been influenced by the state of health status of end users. During the summer the end user was affected by a transient ischemic attack that may have affected her mood and the feeling of loneliness and perceived social support at the time of assessment independently from the use experience of the telepresence robot.

6.2.2.2 Robot Acceptance

The mean scores of each Almere model acceptance constructs (Figure 61) show that at time S0 end user's level of anxiety (ANX) related to the use of the robot is very high. The trend of this score over time shows a significant decrease in anxious feeling by the user.
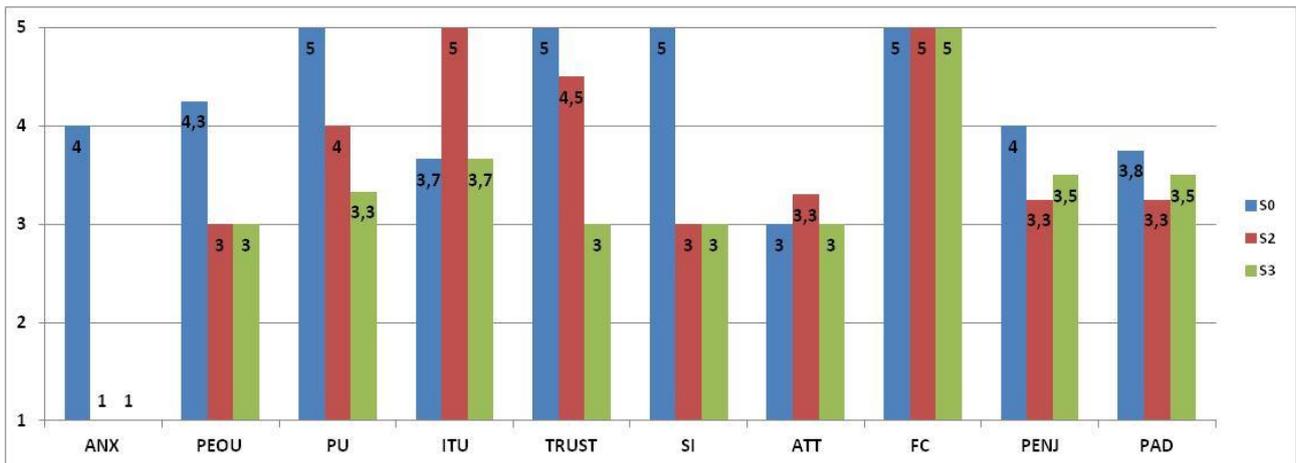
Figure 61: Mean scores for each Almere Model constructs
(5 points Likert scale, from 1= completely disagree to 5= completely agree)

Referring to each dimension of the functional and social robot's acceptance, the graph in Figure 61 show a noticeable decrease over time of Perceived Ease of use (PEOU) and Usefulness (PU), Intention to use (ITU) the robot, Trust and Social Influence (SI).

The attitude (ATT) toward the robot remains neutral over time.

The score's trend related to the environmental conditions of Facilitation of Use (FC) indicates a good perception by the end user of the factors that can facilitate the use of robots at home.

Initially, the end user reports a high perception of enjoyment (PENJ) during the interaction mediated by the robot. Over time the feeling of enjoyment decrease.

The robot's ability to adapt to the needs of the end user (PAD) remain stable and rather moderate.

6.2.2.3 Attitude and affective response toward the robot

Figure 62 shows the mean scores of end user's attitude toward the robot.

The robot is not perceived as an factor of intrusion into domestic life.

The advantages of the use and of the presence of robots at home are recognized and appreciated.

The end user does not show an attitude of distrust toward the robot.

There is limited satisfaction with the robot's features and a moderate concern related to the technical management and maintenance.
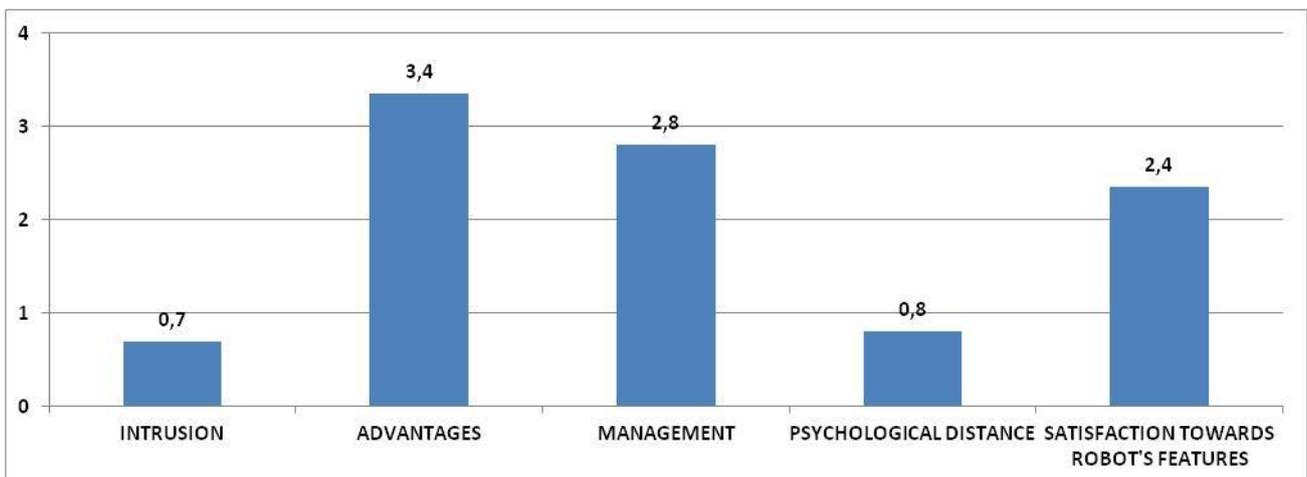
Figure 62: Mean scores for each dimension
(5 points Likert scale, from 0= completely disagree to 4= completely agree)

The end users reported a moderately positive affective response toward the use experience with the telepresence robot. Specifically, the score of subscales on PANAS scale was respectively 35 for Positive Affects and 24 for Negative Aspects.

6.2.2.4 Telepresence dimensions

The quality of interaction in terms of Social Presence (in terms of the feeling of being together) and Social Richness (in terms of subjective experience of warmth and intimacy in the mediated Interaction) during the interaction mediated through the robot are extremely satisfying.
In addition, the end user has a high perception of Co presence (the sense of being with another person in the same room).
The perceived Enjoyment during the interaction mediated by the robot is less satisfying. (Figure 63)
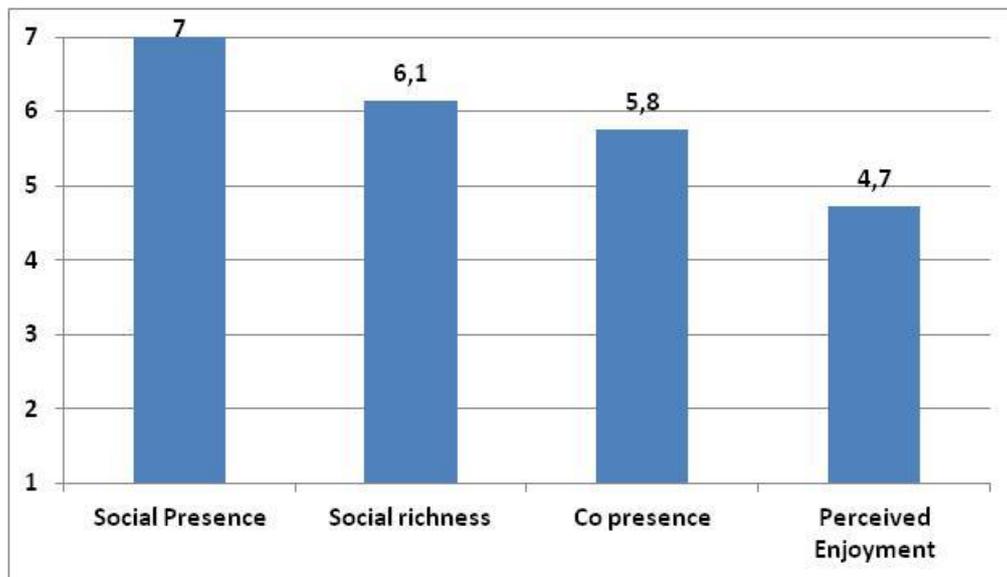
Figure 63: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

6.2.2.5 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

The use of the telepresence robot has not had a significant psychosocial impact on the quality of life of the end user. Comparing the scores of the three subscales of the PIADS is possible to observe that a slight improvement was obtained mainly from the point of view of **Adaptability** (M = 1.2), with a significant increase in the Willingness to take chances, Eagerness to try new things and Ability to take advantages of opportunities.
Using of robot has a minimum impact in terms of **Competence** (M=0.3) and in particular in Expertise. The graph in Figure 64 show also a slight increase of Self Confidence and a more

substantial rise in Frustration indicative of feelings of disappointment toward the robotic device (Figure 64)
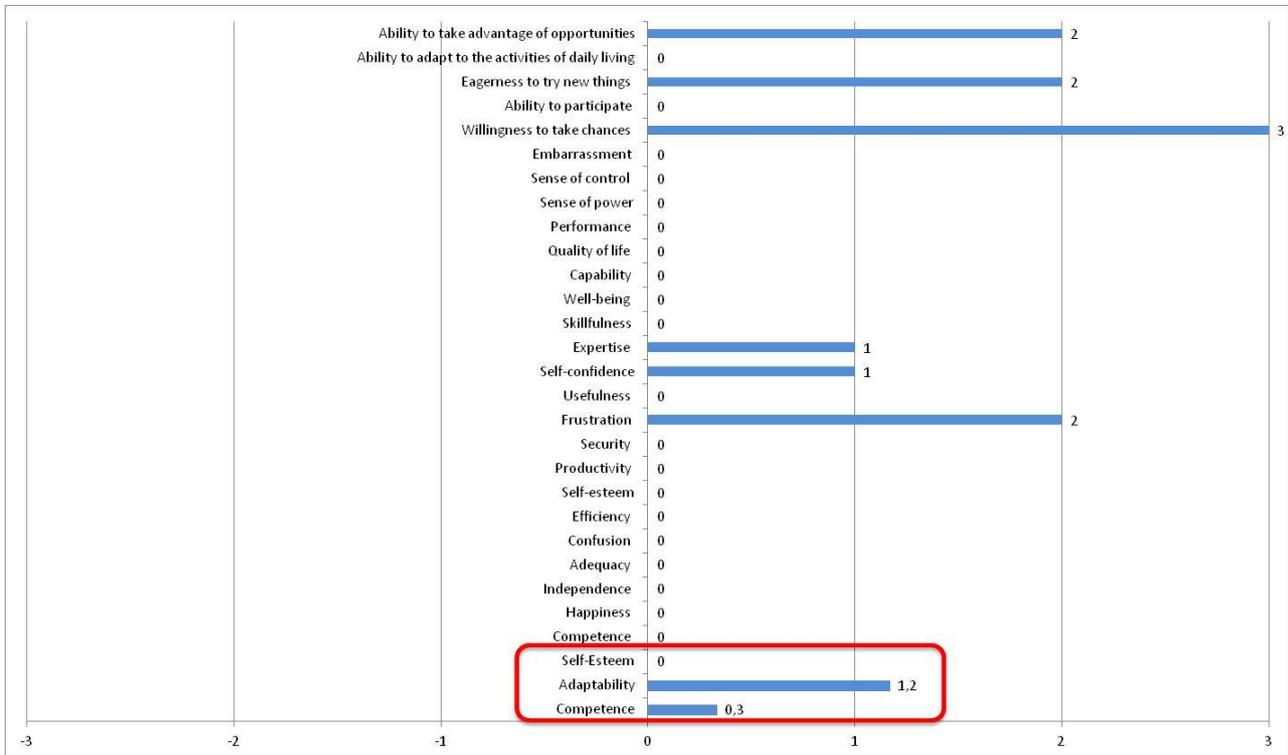
Figure 64: Mean score on three sub scale of Piads distribution of response.
Scale from -3 [Decreases] to + 3 [Increases]

6.2.3 Pilot side

6.2.3.1 Expectations toward the telepresence system

As shown in Figure 65, the expectations were not met over time and for this reason the pilot decide not to answer the questionnaire at time S4.
Specifically, at time S0 the pilot has high expectations toward the telepresence system perceived as support to:
- maintain more stable and frequent contact with her;
- alleviate the loneliness of end user;
- everyday communication with the end user;

The pilot also believes that the use of the system can help him to feel more close to the end user.
At S2 these expectations were disappointed.

However, the pilot does not believe that a telepresence system may be a threat to the domestic privacy of end user. In addition, the usage of the system does not have an adverse impact on the human relationship nor on the opportunities for physically visits.
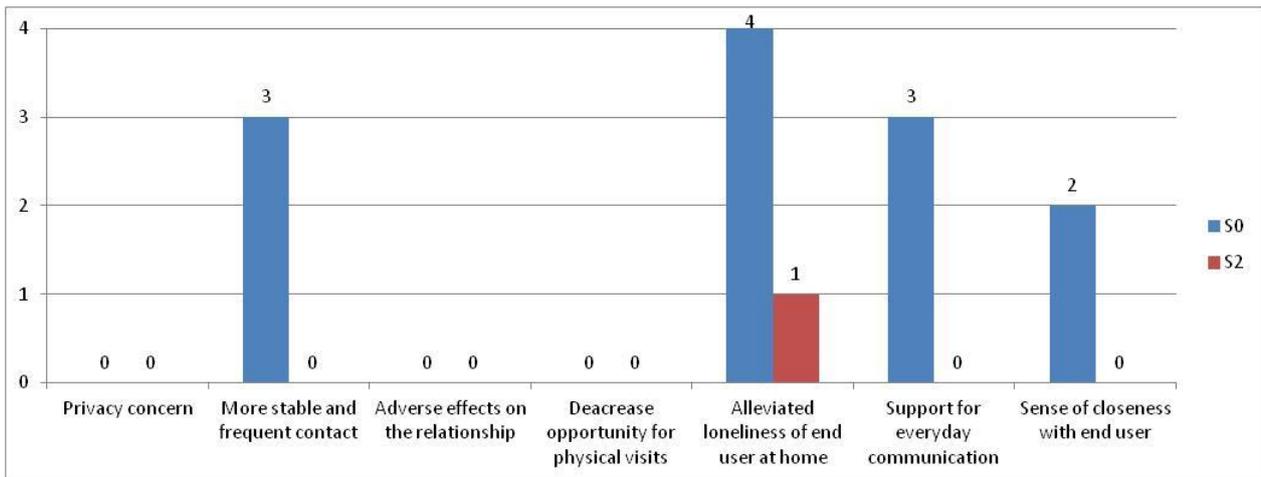
Figure 65: Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system (5 point Likert scale from 0=not at all to 4=very much)

6.2.3.2 System Usability Scale - Ease/Difficulty of learning and use functions' and commands' interface

The subjective usability analysis of telepresence system has been explored according to the distribution of the responses on the SUS scale and on the questionnaire ad hoc to assess the ease/difficulty of learning and use functions' and commands' interface.
The SUS score indicates a good level of usability subjective perceived by the user pilot (92.5).
This result is also confirmed by the distribution of responses to the questionnaire at time S1 and S2. (Figure 66).
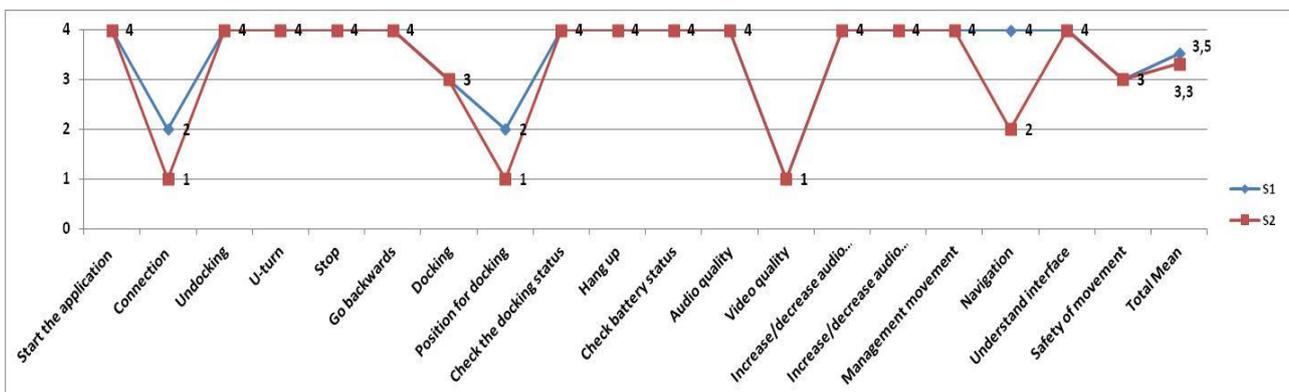
Figure 66: Questionnaire distribution on pilot response to usability assessment
(5 points Likert scale from 0 = very difficult, 4 = very easy)

The ease of learning and use of most of the interface's functions and commands remain stable over time with the exception of the functions related to the Connection, Position for docking, Video and Navigation. These functions become more difficult between S1 and S2.

6.2.3.3 Telepresence dimensions

Regarding the telepresence dimensions of *Temple Presence* and *Networked Minds Social Presence Inventory* reported in Figure 67, the pilot perceives a satisfactory level of Social richness (subjective experience of warmth and intimacy in the mediated Interaction) and Spatial presence (sense of being physically located in a virtual environment).

He report a poorly perception of Co-presence (psychological connection to and with another person) and Social Presence (feeling of being together) and a very low Perceived psychological engagement (extent to which the user feel mentally immersed in the experience), and Perceptual Realism (experience in which the mediated interaction accurately simulates or reproduces the sensory experience that would be expected in the non-mediated interaction) and Perceived behavioral interdependence (extent to which a user's behavior affects and is affected by the interactant's behavior).
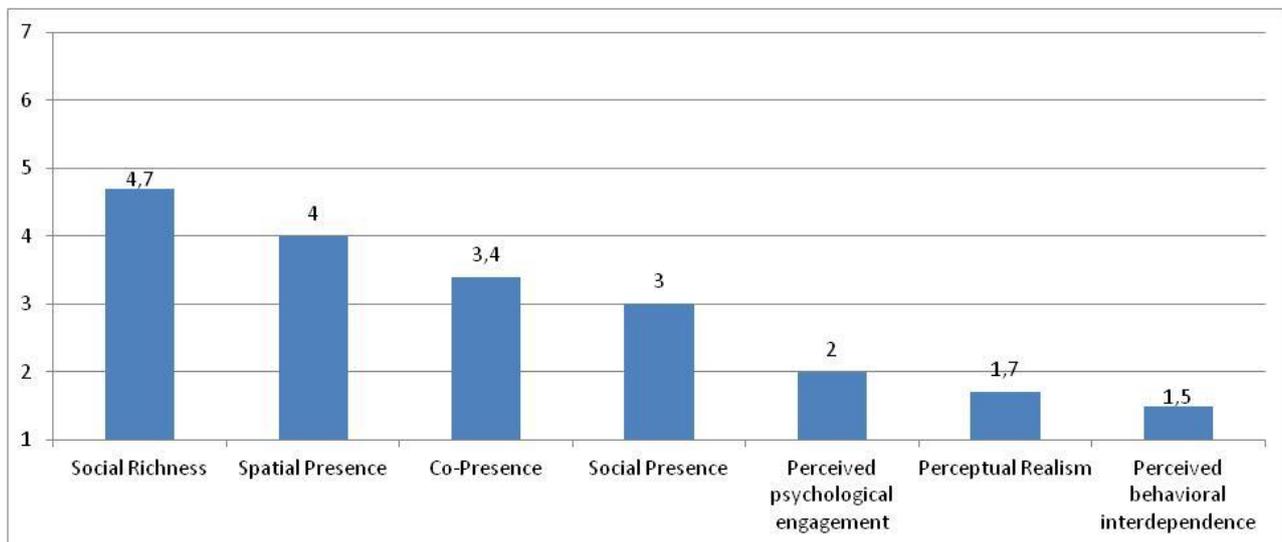
Figure 67: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

6.2.3.4 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

Analyzing the scores obtained from the three subscales of the PIADS (Figure 68) it can be stated that the use of the Giraff system has led to an improvement in terms of **Adaptability** (M = 1.83) and specifically in Ability to take advantages of opportunities, Ability to adapt to the activities of daily living, Eagerness to try new things, Ability to participate and Willingness to take chances.

The mean scores obtained from the **Ability** (-0.08) and **Self Esteem** (-0.13) subscales are indicative of a negative impact of telepresence system in terms of a change in the quality of life of the pilot user.

In particular the use of the telepresence system has affected negatively:

- the ability to demonstrate own skills (Performance)
- the ability to do more things in a day (Productivity)
- the ability to manage daily tasks efficiently (Efficiency)

- the feeling to be not dependent on someone or something, or constant need for outside help (Independence)

The use of the system has increased feelings of disappointment (Frustration) and the perception of being not able to act decisively (Confusion) .

Finally, a slight positive impact is noticeable in the following components:

- feeling more capable (Capability);
- ability to show own expertise (Skillfulness);
- trust in own abilities (Self Confidence);
- feeling to be helpful to ownself and others (Usefulness).
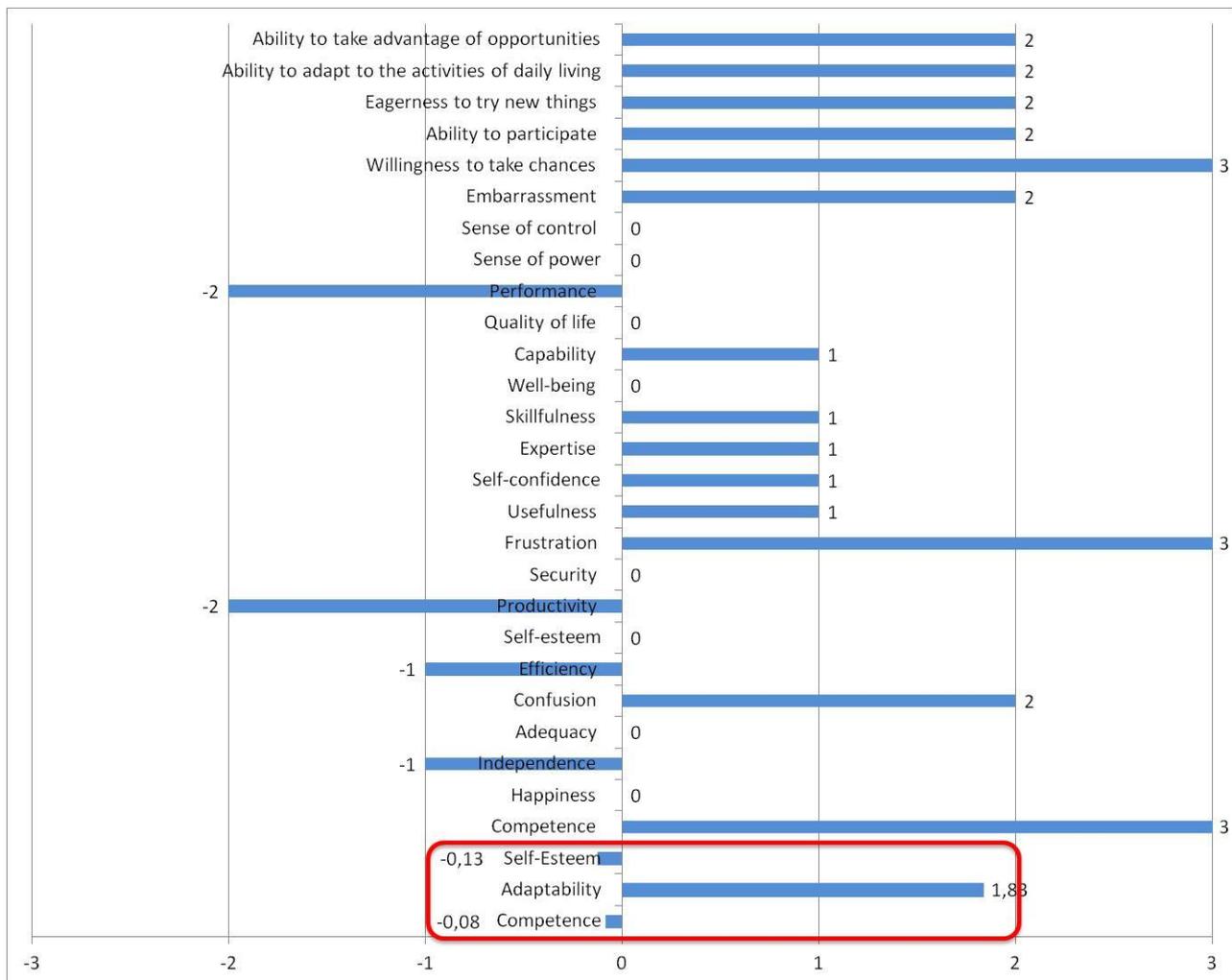
Figure 68: Mean score on three sub scale of Piads distribution of response.
Scale from -3 [Decreases] to + 3 [Increases]

6.2.3.5 *Affective state related to the use experience and interaction through telepresence system: PANAS scale*

The scores obtained respectively for the PA subscale (positive affect) and NA (negative affect) of the PIADS, are 34 Vs. 22. These scores are indicative of a generally positive affective response toward the long-term use experience with the telepresence system.

6.3 <u>Test site Italy 4</u>

The entire long-term experience lasted 1 year, from August 2012 to December 2013.

6.3.1 Participants

End User: The older user is affected by Parkinson's disease since 2005. Both his walking ability and the speech were deeply compromised by the severe stiffness in movement as well as the muscle rigidity of the face. In particular, due to the speech restriction, the user often refuses the communication with the others and prefers to stay alone. The fear of feeling bad outside home and the difficulty in speech have led to a progressive departure from the community life. The interruption of his social life has caused him relevant mood alterations: sometimes, he has reported to be very depressed and feel that anyone could help him. Currently, he lives with his wife, in the centre of a small town. He can reach by feet all the most important places in the town and the seaside too. His wife is a very active woman instead, and she takes care of him constantly. His son (the Client) and his daughter live far from the town (respectively 30 and 60 Km), so he does not see them very much. He is currently engaged in physical rehabilitation and speech therapy. The user has showed some basic skills with technology, mainly motivated by his interests: he is able to use Internet connection, to play online games. In addition, he is able to use the mobile phone basically, just for calling but not for sending text messages or photos, for example, while he uses daily the digital TV for looking at sport events.

Pilot User: The Client is the son of the older user. He lives with his family 30 Km away from the town of the user. Due to work commitments and family reasons, he can't see his father often, and he is worry about the user's health status, that seems to be worsened in the last year. The Client is 34 years old. He currently works as employee in a public institution, in the centre of Italy. He is a dynamic person, engaged in sport activities as well as very interested in technology. He is able to operate pc, tablet, smart phone and all the software applications for entertainment and work and domestic appliances.

When he was living with his father and mother, he was the main user of technologies at home, so he explained to the user how to upload a new software program, for example, or how to play on line games. Also now, he is the person who they contact in case of need, for supporting them with the technologies.

6.3.2 End User side

6.3.2.1 Psychological measures

The results of Geriatric Depression Scale (GDS) at time S0 and S1 show scores substantially comparable, indicative of the presence of moderate depressive symptoms (score between 10 and 19). Similarly, the scores on the perceived loneliness scale (UCLA) indicate an experience of severe loneliness (UCLA score = 52 at S0, UCLA score = 47 at S1).

The score of the Short Form-12 Health Survey (SF-12) show Low mean meta scores of the Physical Component Summary (M=23.5) and Mental Component Summary (M=38.4) of the score denote a perceived health condition characterized by significant limitations in self-care and in physical, social and personal.

In the pre-adoption time (S0), the scores of the Multidimensional Scale of Perceived Social Support Scale (MSPSS) indicate that the end user perceives a higher social support from family with respect to that received from the friendships network and /or from significant other persons close to the user (Figure 69). After the adoption and the first period usage of the robot (S1), the family continues to be the main source of perceived social support, while the perceived support from the friendships network decreases further, and the feeling of social support from significant other persons increases to some extent respect to the time S0. Nevertheless, this increase does not seem indicative of a clear perception and over time the family remains stable continuing to be the clear source of perceived social support for the end user.
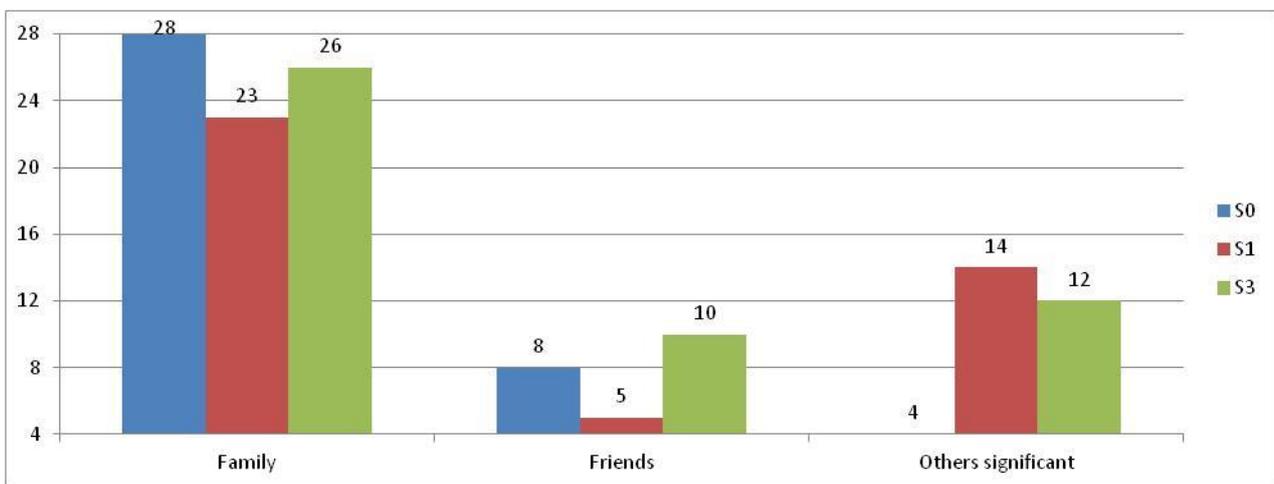
Figure 69: Total scores for each dimensions of MSPSS obtained from the sum of the responses from the items in each of the three dimensions (range score 4-28).

6.3.2.2 Robot Acceptance

The mean scores of each Almere model acceptance constructs (Figure 70) show an increase over time of Facilitating Conditions (FC) and of Social Influence (SI). The end user ever more recognize the presence of factors in the environment that facilitate use of the robot and he perceive that people who are important to him think he should use the robot.

The ability of the telepresence robot to adapt to the needs (PAD) of the end user is stable and highly perceived.

End user's Intention to use (ITU) the robot for long time, Perceived Usefulness (PU) and Trust are constant and rather satisfying during the steps of the evaluation.

At time S0 and S2 the presence and the usage of the robot evoke moderate anxious feelings (ANX) that at time S3 become less strong.

Nevertheless, the graph in Figure 70 illustrates that feelings of joy/pleasure associated with the use of the robot (PENJ) are not on the whole strongly perceived. In addition, the attitude (ATT) toward the robot is doubtful and the Perceived ease of Use (PEUO) decrease slightly over time.
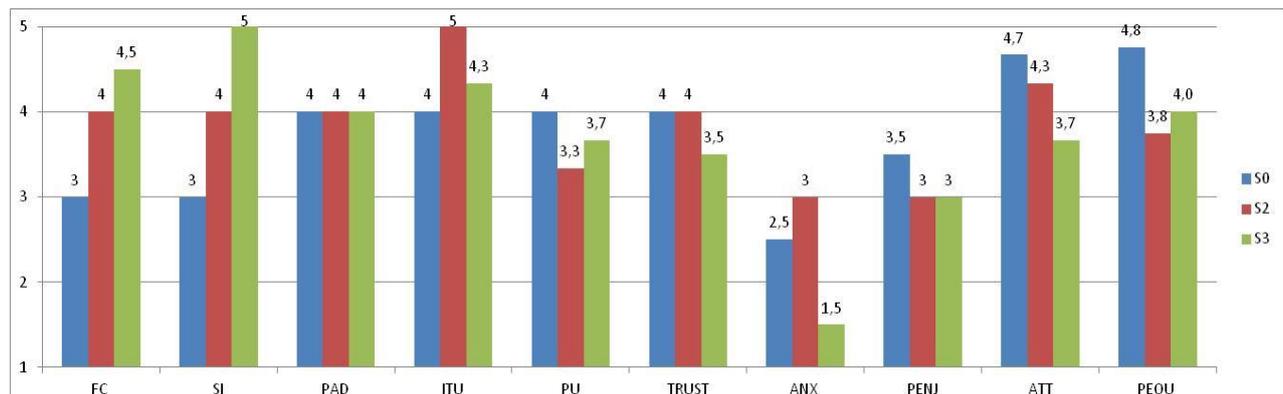
Figure 70: Mean scores for each Almere Model constructs
(5 points Likert scale, from 1= completely disagree to 5= completely agree)

6.3.2.3 Attitude and affective response toward the robot

Based on the dimensions of attitude and evaluation described in (Cesta A. 2011), Figure 71 shows the results of the questionnaire related to significant dimension of evaluation from the primary user's perspective Specifically at time S1, after the adoption and the first period of usage, the user does not perceive a high level of intrusion into his privacy (M=0.67), does not show distrust in terms of psychological distance between himself and the adopted aid (M=0.60), and recognizes the benefits and advantages (M=2.79), of the system related to his needs (e.g. Giraff simplifies the management of daily life or relieves the workload of people who take care of me). Nevertheless he shows a partial satisfaction of the Giraff's functionalities and features (M=2.47), (e.g., the quality of the video and the movement of the robot are not very satisfactory) and some notable apprehension related to the difficulty of maintenance of the robot (3.25), maybe justified also by the technical difficulties that emerged.

Furthermore, the user would like additional features of the robot like for instance the possibility to have a direct link with his doctor via Giraff. The emotional reaction of elderly user to the robot is very good, scoring high on the positive adjectives useful, interesting, stimulating, and funny, and very low on the negative adjectives scary, overwhelming, gloomy, dangerous, and uncontrollable.
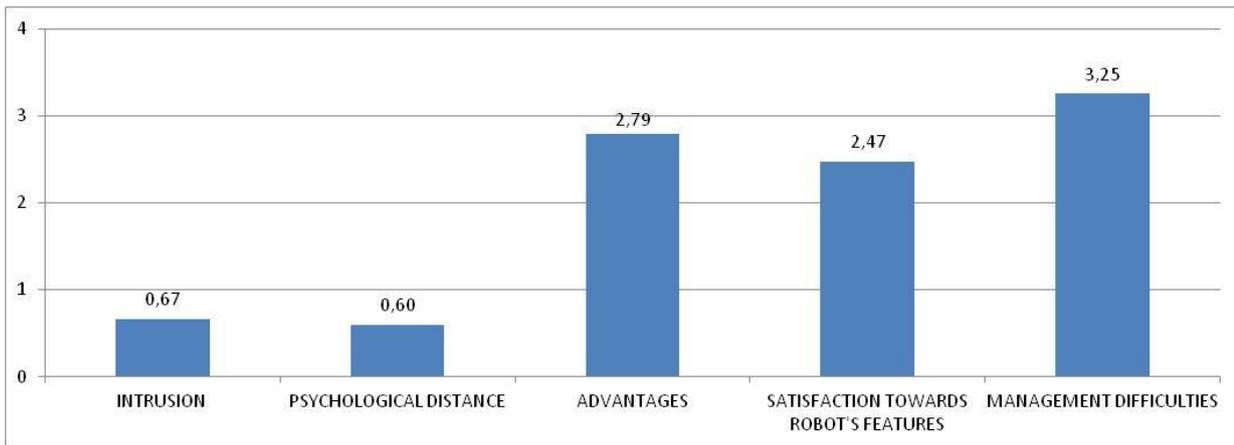
Figure 71: Mean scores for each dimension
(5 points Likert scale, from 0= completely disagree to 4= completely agree)

The end users reported a moderately positive affective response toward the use experience with the telepresence robot. Specifically, the score of subscales on PANAS scale was respectively 23 for Positive Affects and 14 for Negative Aspects. This positive affective reaction leads the end user to perceive the robot as very pleasant, useful, fun and stimulating. However some negative affective responses emerge describing the robot as moderately cumbersome and worrisome.

6.3.2.4 Telepresence dimensions

The end user has a good experience during the interaction mediate through the robot in terms of pleasantness during the robot usage (**Perceived Enjoyment**), of subjective experience of warmth and intimacy in the mediated interaction (**Social Richness**) and of the perception of being together (**Social Presence**) the secondary. In addition, the feeling of psychological connection to and with another person (**Co-presence**) is very satisfactory (Figure 72).
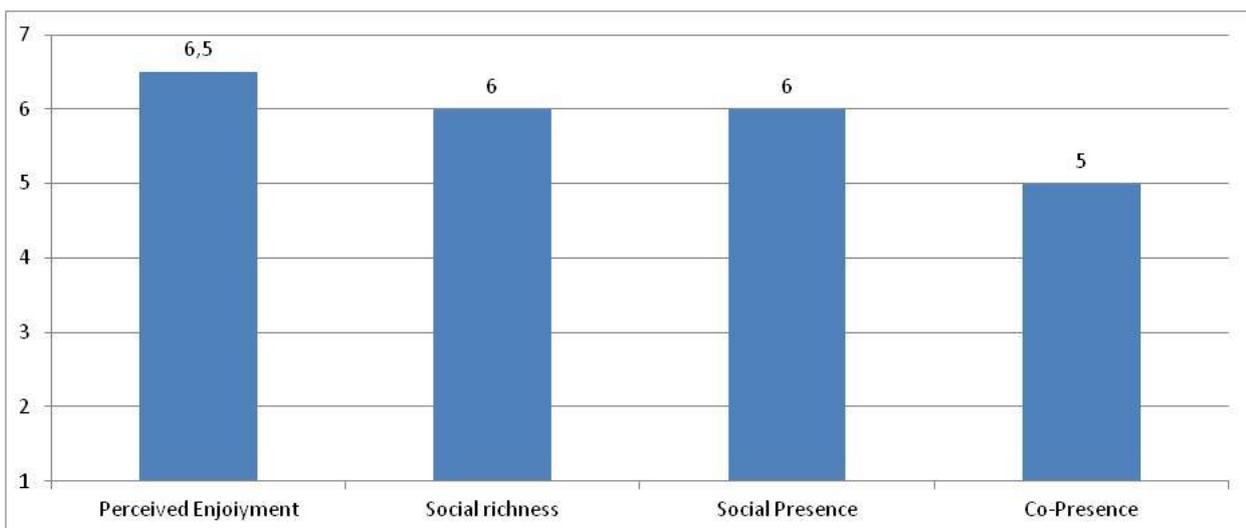
Figure 72: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

6.3.2.5 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

Considering end user's perspective the robot has a slight psychosocial impact on everyday life. Comparing the scores of the three subscales of the PIADS questionnaires it is possible to note a small improvement in terms of Competence (M=1.2) and Adaptability (M=1.2). (Figure 73)

Referring to perception of functional capability, independence and performance related to the use of the robot (Competence), the user perceives an enhancement in Skillfulness, Capability, Expertise and Independence..

In terms of Adaptability, using of robot has a positive impact reducing individual Eagerness to try new things, Ability to participate and Willingness to take chances.

No real improvement in terms of ability has been found in Self Esteem.
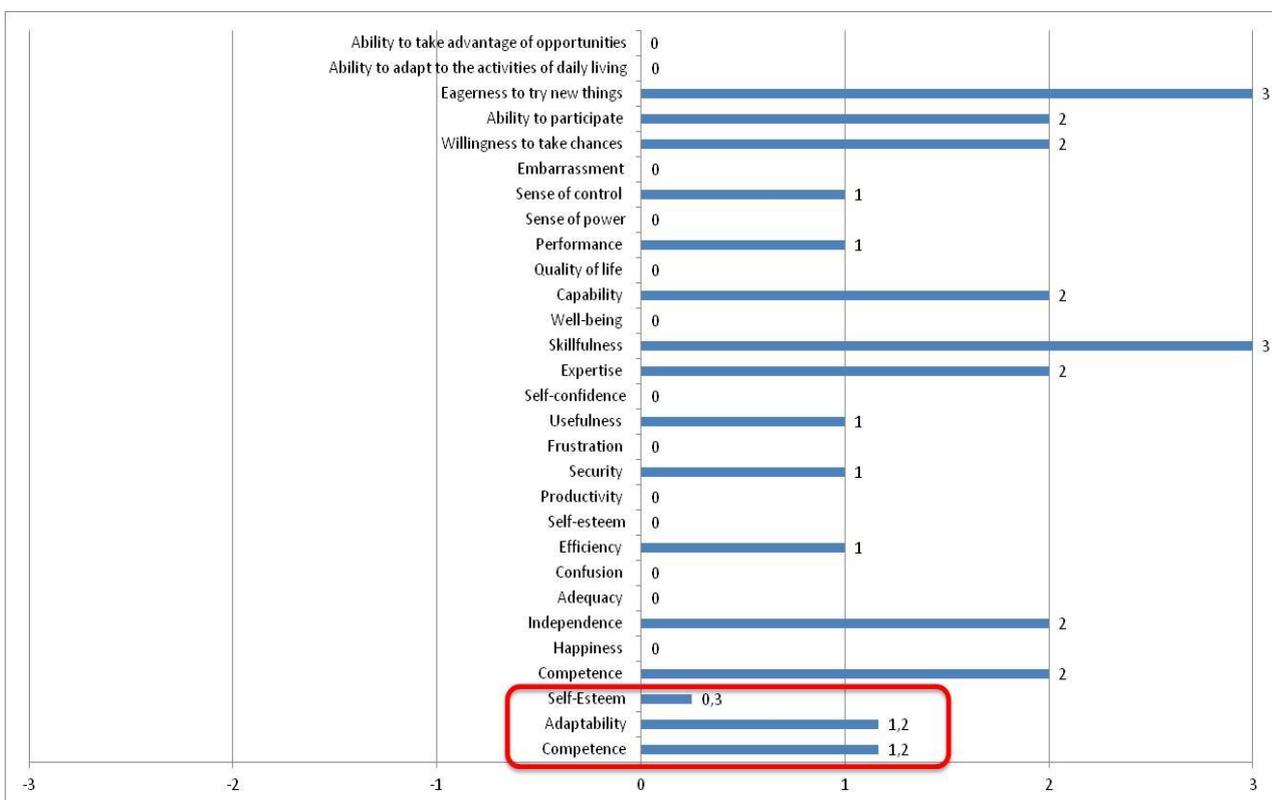
Figure 73: Mean score on three sub scale of Piads distribution of response.
Scale from -3 [Decreases] to + 3 [Increases]

6.3.3 Pilot side

6.3.3.1 Expectations toward the telepresence system

Pilot's expectations remain fairly stable between S0 and S2.
At the beginning of the experience the pilot does not expect that the telepresence system and the robot's presence in the end user's house may be a threat to the domestic privacy or a manner to decrease the physical visits. In addition, the pilot suppose that the usage of the system may be not an adverse effect on on human relationship. In this phase, the pilot is sure that the system can be

a means to have more stable and frequent contacts with the end user supporting everyday communications and alleviating the older user's sense of loneliness. He affirms the possibility to feel closer with the end user using the telepresence system ()

During the use experience with the system (S2)it is interesting to note that the pilot' changes his mind about some of the initial expectations. In particular, he does not believe that the system can be a mean to have more stable and frequent contacts with the end user. A slight decrease emerges also for the expectations related to the value of the system as a means to support everyday communications, to alleviate the older user's sense of loneliness and to feel closer with the end user.
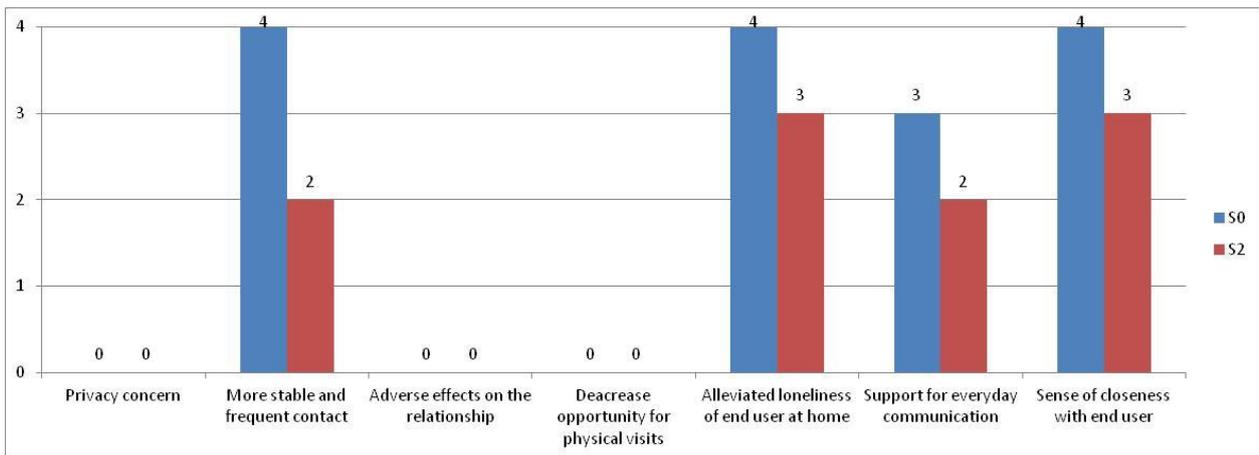
Figure 74: Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system (5 point Likert scale from 0=not at all to 4=very much)

6.3.3.2 System Usability Scale - Ease/Difficulty of learning and use functions' and commands' interface

The analysis of the SUS questionnaire showed a score of 95 representative an optimal level of subjective usability of the Giraff's client interface. This result is also confirmed by the questionnaire on the usability of the system we developed ad hoc for the case study.

Although, the initial opinion about the ease or difficulty of learning and use functions' and commands' interface is rather good (M=3.3), the Figure 75 shows that functions related to the docking (docking, position for docking and check the docking status) are considered to be very difficult.

After the first period of usage (S2), the usability of the system is still satisfactory (M=3.6) but the difficulties related to the docking functions remain demanding.
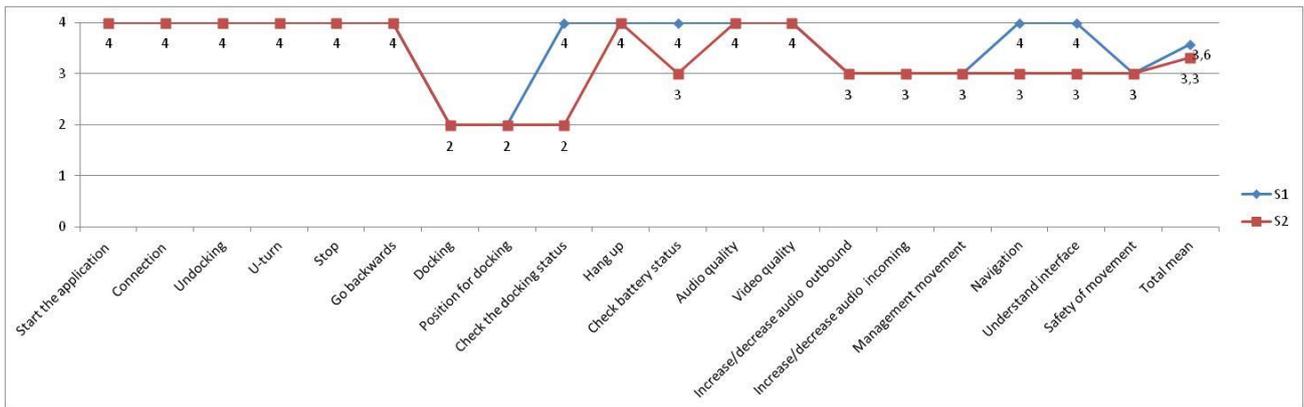
Figure 75: Questionnaire distribution on pilot response to usability assessment
(5 points Likert scale from 0 = very difficult, 4 = very easy)

6.3.3.3 Telepresence dimensions

Regarding the telepresence dimensions of Temple Presence and Networked Minds Social Presence Inventory the secondary user experiences a good sense of Social Presence (feeling of being together) and Perceived behavioral interdependence (extent to which a user's behavior affects and is affected by the interactant's behavior). In addition, he reports high degrees of Perceived psychological engagement (extent to which the user feel mentally immersed in the experience) Perceptual Realism (experience in which the mediated interaction accurately simulates or reproduces the sensory experience that would be expected in the non-mediated interaction) and Social richness (subjective experience of warmth and intimacy in the mediated interaction).
Spatial presence (sense of being physically located in a virtual environment) and of.
The perception of Co-presence (psychological connection to and with another person) is moderate while the Spatial presence is poorly perceived. (Figure 76)
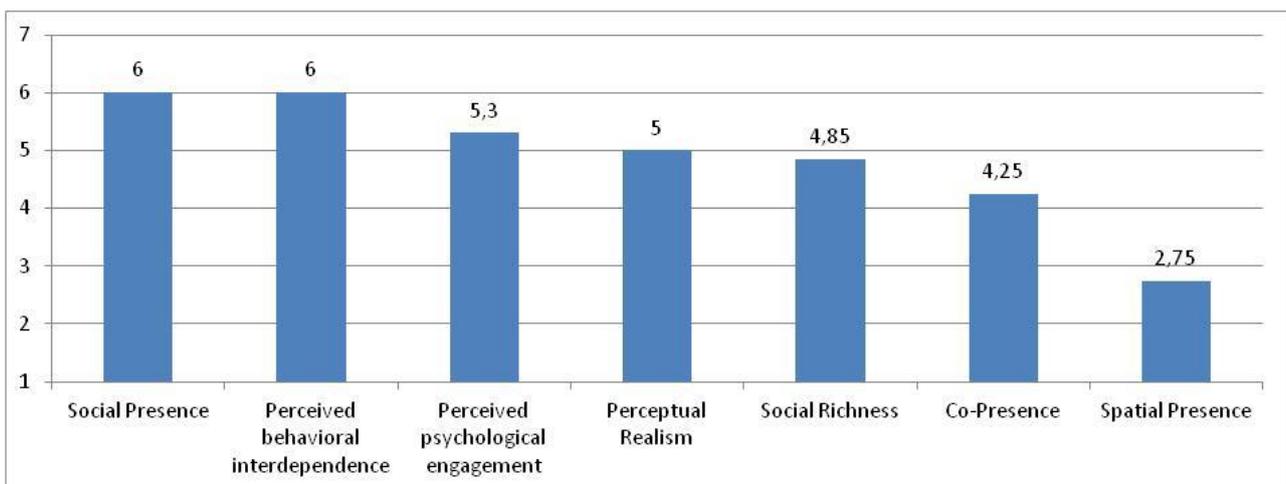
Figure 76: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

6.3.3.4 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

Analysis on the PIADS scale reveals that overall the service offered through Giraff telepresence system did not have a particularly effective psychosocial impact on the secondary user's life, not causing any remarkable changes

From the point of view of the three sub-scales of the PIADS it is possible to say that a small improvement has been obtained especially with respect to Adaptability (M=1) with a considerable increase in Willingness to take chances. Slights increases is possible to note also in Abilities to adapt to the activities of daily living, to participate and to take advantages of opportunities.

Very slight change are obtained in terms of Competence (M=0.7) and in particular in Capability, Expertise, Productivity, Efficiency, Adequacy and Independence.

Referring to Self-Esteem, the use experience with the telepresence system does not have a clear impact but it is possible to note a strong increase of Frustration. (Figure 77).
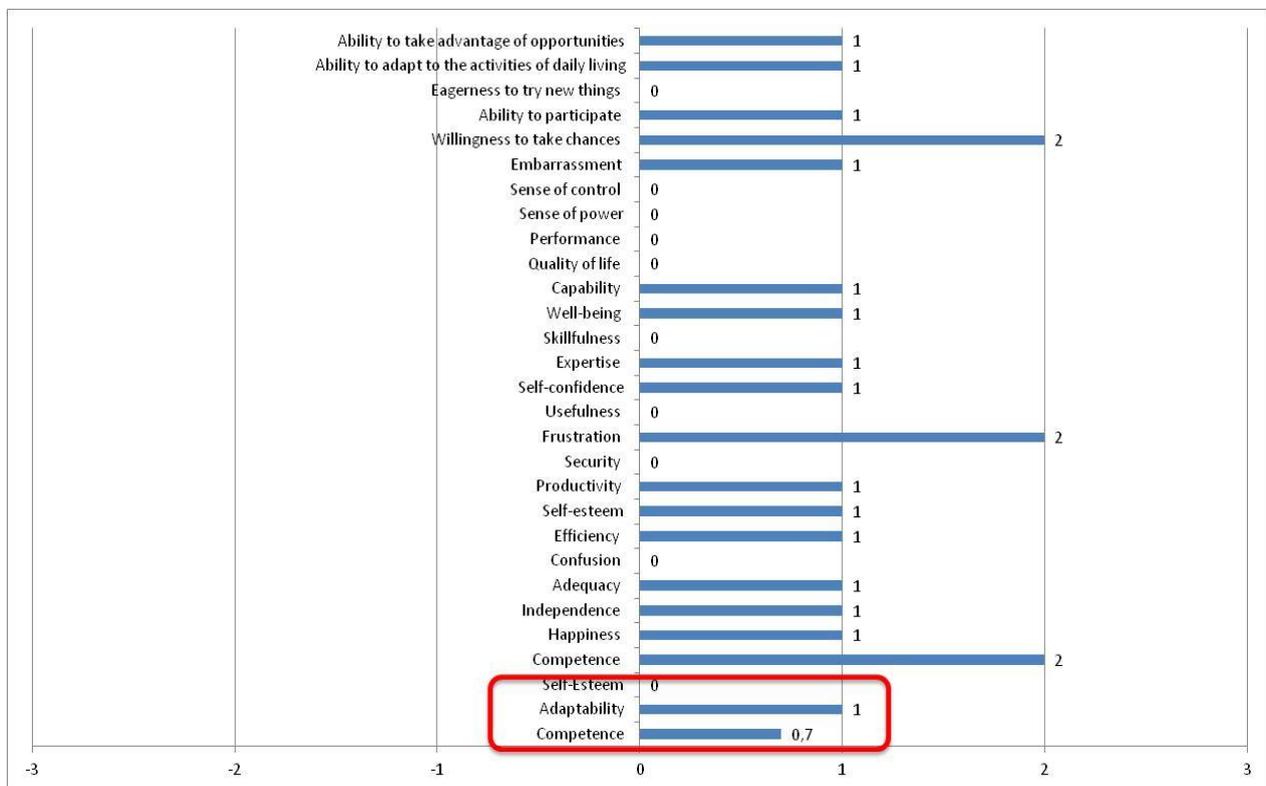
Figure 77: Mean score on three sub scale of Piads distribution of response.
Scale from -3 [Decreases] to + 3 [Increases]

6.3.3.5 Affective state related to the use experience and interaction through telepresence system: PANAS scale

Positive affect subscale show higher scores (31) than Negative Affect subscale (11) and this result indicate that end experiences a pleasurable engagement with the technology.

6.4   Test site Italy 5

The entire long-term experience lasted 1 year, from March 2013 to December 2013

6.4.1 Participants

End User: 72 years older woman, with primary education. The end user has own home in Rome in which she has a self supporting life. Her apartment is on the first floor of a condominium and it is organized on a single level.

The end user has a good knowledge of modern information and communication technologies. She makes daily use of the computer and of the mobile phone. She is able to surf the internet and she has and manages a mail box .

The end user spends several hours a day at the computer visiting blogs, forums, social networks. As a consequence of her frail mental and physical health status she follows a specific pharmacological therapy and she complains a condition of social loneliness.

Once a week the end user benefits of home help service for some daily life tasks. In addition, she attends the neighborhood's senior center. During the time at the senior center, end user's principal activity is related to the care of the garden and to the assistance to the most needy users. This senior center is run by a social and assistance services cooperative of Rome by which our team met the end user. The cooperative's staff has decided to take part in the project indicating this end user as a suitable subject for the user-centered evaluation required in the project .

The user's familiarity with the technology, the need of social support and the opportunity to test a means of alternative communication with the senior center's social assistance workers represent the main user's motivations to take part in the evaluation.

Pilot Users: two social assistance workers are the pilots of this case study. Both clients working at a day care center for frail elderly run by the aforementioned social and assistance services cooperative.  Prior to enrollment in the case study, the two pilots have never met the end user. A first meeting between all users of the case study was organized at the senior center in order to check the availability of end user to accept a service of social support at a distance throourgh the telepresence system.

The pilot A is a 55 year woman with a bachelor of social service and 20 years of experience in the elderly assistance. The pilot has a good knowledge of modern information and communication technologies. She makes daily use of for reasons mainly related to her work.

The pilot B is a 48 years woman with graduate education. She is the coordinator of that day care center. Even the pilot B has a good knowledge of information and communication technologies and she makes daily use of computers mainly for reasons related to her work.

6.4.2 End User side

6.4.2.1 Psychological measures

Over time, the results of Geriatric Depression Scale (GDS) show scores substantially similar over time, indicative of the presence of mildly depressive symptoms (score between 10 and 19). In addition, the end user perceives a significant sense of loneliness at S0 (UCLA score = 42) which does not change in the following steps of evaluation.

The feeling of loneliness is also reflected in perceived social support. The initial total score (S0) of the Multidimensional Scale of Perceived Social Support Scale (MSPSS) is 45 (range score 12-84; the higher the score the higher the perceived social support). In particular the three subscales scores indicate that at time S0 the end user perceives a higher social support from friends (sum of the scores=22) and significant other persons (sum of the scores=19) with respect to that weakly received from the family (sum of the scores=8). Over time S1 and time S3, the perceived social support from family show slightly increases. On the contrary social support from friend decreases while support from significant other persons noticeably increase (Figure 78)
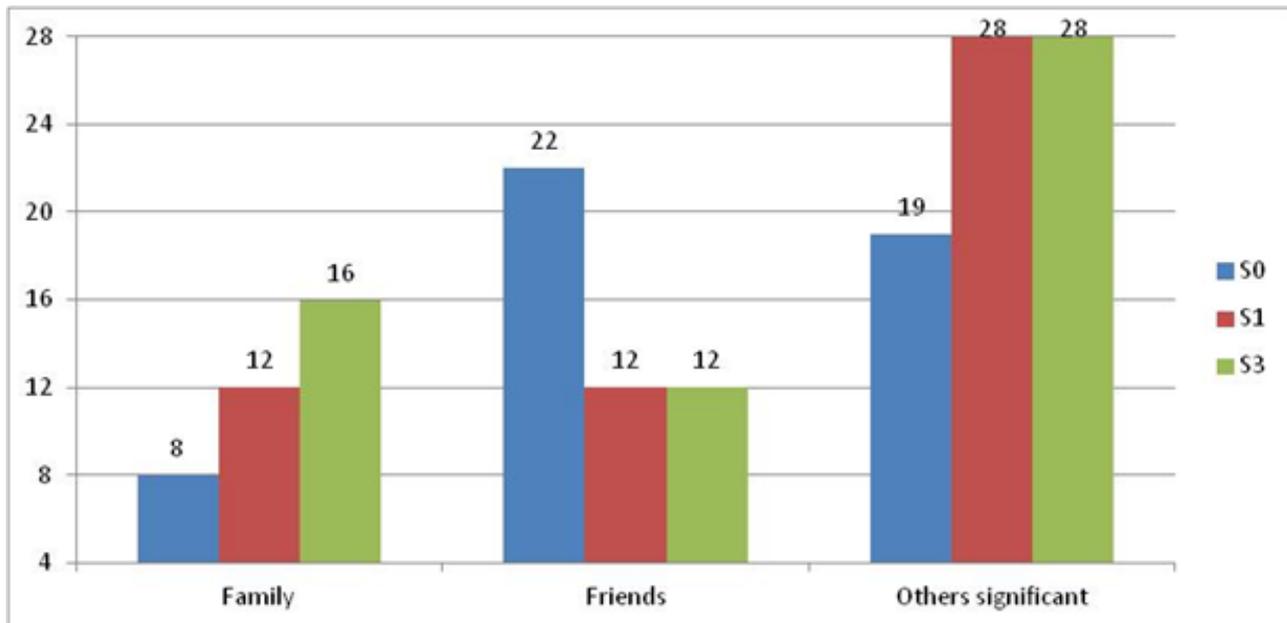
Figure 78: Total scores for each dimensions of MSPSS obtained from the sum of the responses from the items in each of the three dimensions (range score 4-28).

The end-user perceives overall frail health status conditions especially in terms of limitations in social and personal care activities due to important physical pain. At time S0 the mean meta scores of the Physical Component Summary of Short Form-12 Health Survey (SF-12) is 32.7. This score decrease over time (M (S3)=22,2) indicating a deterioration of physical health associate with a mental health status perceived as consistently vulnerable (Mental Component Summary M=39). Because of deterioration of end user's health conditions and personal issues has not been possible to complete the evaluation plan at the time S4.

6.4.2.2 Robot Acceptance

The mean scores of each Almere model acceptance constructs show that at time S0 end user's has very positive feelings about the appliance of the robot (ATT). She perceives completely the ability of the robot to adapt to the her everyday needs (PAD) and consequently the Intention of Use (ITU) and Perceived Usefulness (PU) are very high. Also the end user recognizes factors in own environment that facilitate use of the robot (Facilitating Conditions)and she has the full perception that people who are important to her think she should use the robot (Social Influence). Perceived Enjoyment (PENJ), Perceived ease of use (PEOU) and Trust are perceived as more moderate. The end user does not show Anxiety (ANX) toward the adoption of the telepresence robot.

Looking at the trend of the mean scores for each dimension of functional and social acceptance of the robot, it is possible to note that positive feelings about the appliance of the robot (ATT) decrease at S2. The end user perceives less the ability of the robot to adapt to the her everyday needs (PAD), while Intention of Use (ITU), Perceived Usefulness (PU), Facilitating Conditions (FC), Social Influence (SI) and Perceived Enjoyment (PENJ) remain constant and satisfactory. Perceived of ease of use (PEOU) and Trust show a slight improvement. Nevertheless the robot evoke more anxious reactions (ANX) during the effective experience of usage.

Over time, the general level of acceptance go through an evident worsening at time S3. Although feelings about the appliance of the robot (ATT) remain rather positive, as well as the perception of factors that facilitate use of the robot (Facilitating Conditions)is satisfactory, the mean score of other dimensions decrease over time. The end user perceives a moderate ability of the robot to adapt to the her needs (PAD). Intention of Use (ITU), Perceived Usefulness (PU), Perceived Enjoyment, Perceived of ease of use (PEOU) show a strong decrease. Social Influence (SI) and Trust decreased significantly at time S3. In addition, the use of the robot continue to evoke slight anxious reactions (ANX). (Figure 79)
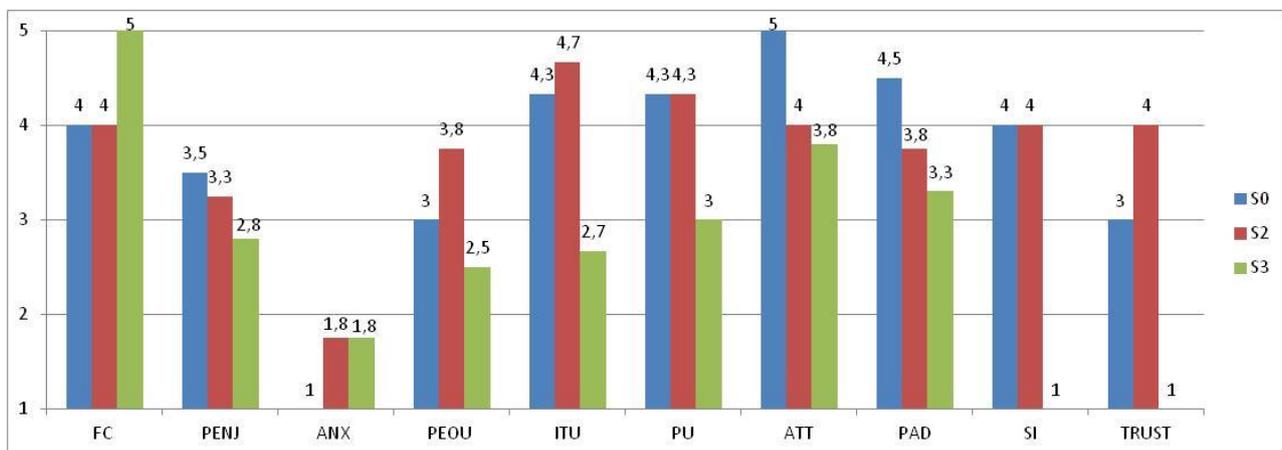
Figure 79: Mean scores for each Almere Model constructs
(5 points Likert scale, from 1= completely disagree to 5= completely agree)

6.4.2.3 Attitude and affective response toward the robot

During the robot's use experience, the end user does not perceive feelings of intrusion into his domestic privacy (M=0.6)and a psychological distance between herself and the adopted robotic aid (M=0.8). Nevertheless, she shows a slight apprehension for management difficulties (M=1.6). In addition, she is rather satisfied of the Giraff's functionalities and features (M=2.6) and she recognizes benefits and advantages related to the everyday use of the robot (M=3.6). (Figure 80). The end users reported a moderately positive affective response toward the use experience with the telepresence robot. Specifically, the score of subscales on PANAS scale was respectively 32 for Positive Affects and 20 for Negative Aspects.
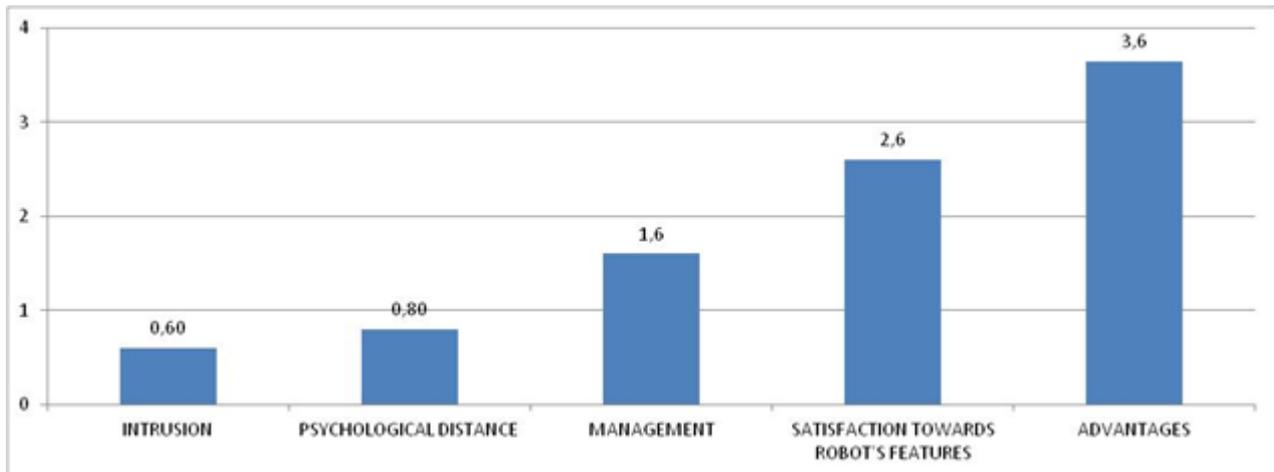
Figure 80: Mean scores for each dimension
(5 points Likert scale, from 0= completely disagree to 4= completely agree)

6.4.2.4 Telepresence dimensions

The end user has a good experience during the interaction mediate through the robot in terms of subjective experience of warmth and intimacy in the mediated interaction (**Social Richness**). The perceptions of psychological connection to and with another person (**Co-presence**) is rather good, while sense of pleasantness during the robot usage (**Perceived Enjoyment**) and of being together (**Social Presence**) the secondary user during the mediated interaction are moderately satisfactory ().
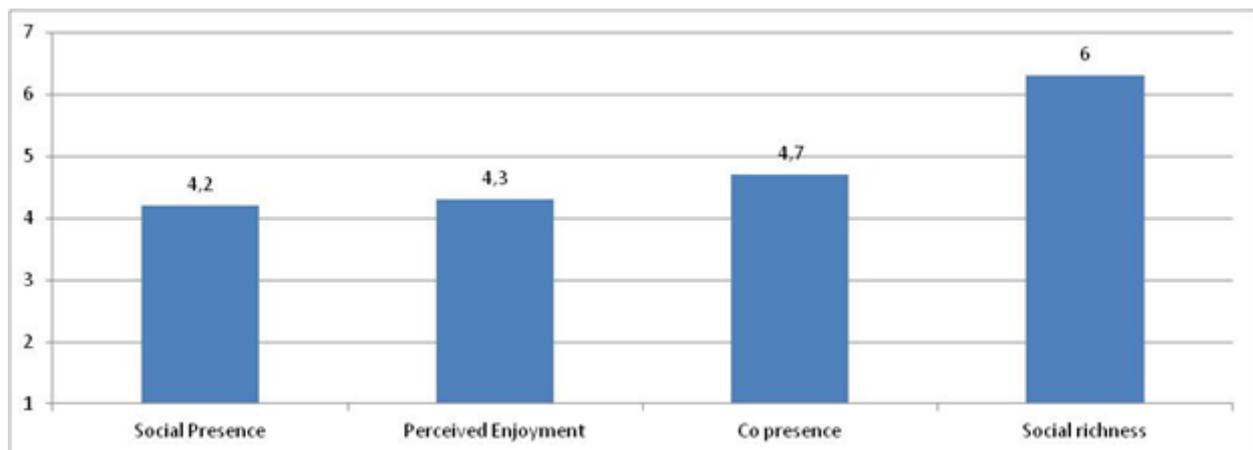
Figure 81: Mean scores of telepresence dimensions
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

6.4.2.5 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

The robot did not have a strong psychosocial impact on end user's everyday life (Figure 82). Comparing the scores of the three subscales of the PIADS questionnaires it is possible to note a

partial improvement in terms of Adaptability (M=1,3) with a considerable increase in Ability to adapt to the activities of daily living, Ability to participate and Well being.

The use of the robot has a minimum impact also in terms of Competence (M=0.5) increasing Quality of life, Skillfulness and Expertise.

No remarkable changes in terms of SelfEsteem.
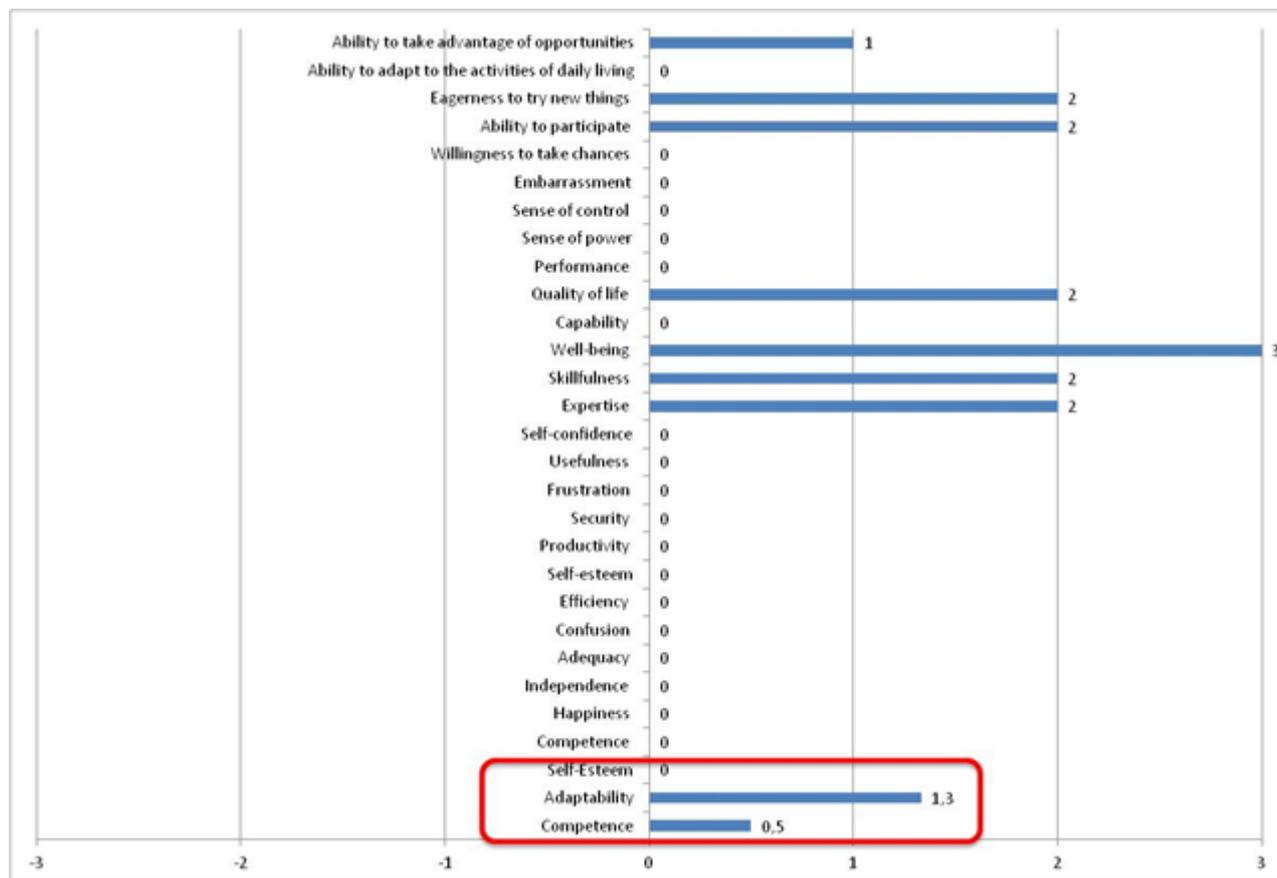
Figure 82: Mean score on three sub scale of Piads distribution of response.
Scale from -3 [Decreases] to + 3 [Increases]

6.4.3 Pilot side

6.4.3.1 Expectations toward the telepresence system

Secondary users' expectations, related to the use of the telepresence system as an aid to provide a service for remote home help assistance, are generally confirmed over time (Figure 83). Specifically, both secondary users do not believe that a telepresence robot may be a threat to the privacy of an older end user. Respect to the support that the system can stand for own profession, the secondary users' expectations about the possibility of telepresence system to improve the older user's time management, to be a support for remote assistance and for management of emergencies are confirmed over time (between S0 and S2). At time S0 the secondary users do not expect to feel reassured by the presence of the robot and by functionalities of the telepresence system. Nevertheless, at time S2 the graph show a remarkable change in this expectation

indicating a good perception of reassurance. From them point of view, the interaction mediated by the robot is an easy way of communication for an older user.

Although the secondary users' initial expectation (S0) about the possibility to alleviate the end user's need for home help service using telepresence system was rather high, at time S2 this expectation does not find its confirmation. In addition, secondary users believe that a home help assistance mediate by a telepresence system may provide a low quality service.

The expectation of the possibility to have more stable and frequent contact with the end user by the telepresence system, improve between S0 and S2 for Pilot A and remain stable and high for Pilot B.

Pilot A does not believe that the use of telepresence does not have adverse effects on human relationship, while Pilot B hesitate at time S0 on this aspect. The use experience of Pilot B improve this expectation.

At S4, after the conclusion of the case study, the expectations expressed at S0 and at S2 are confirmed for Pilot A. This secondary user recognizes that without the telepresence system she feels somewhat a worst user's time management, the need for a support device for remote assistance (confirming the validity of the system for this purpose) and for the management of any unexpected events. In addition, less sense of reassurance and a minimum change in stability of the contacts with end user emerge (Figure 84).

It was not possible to conclude the evaluation plan for the pilot B.
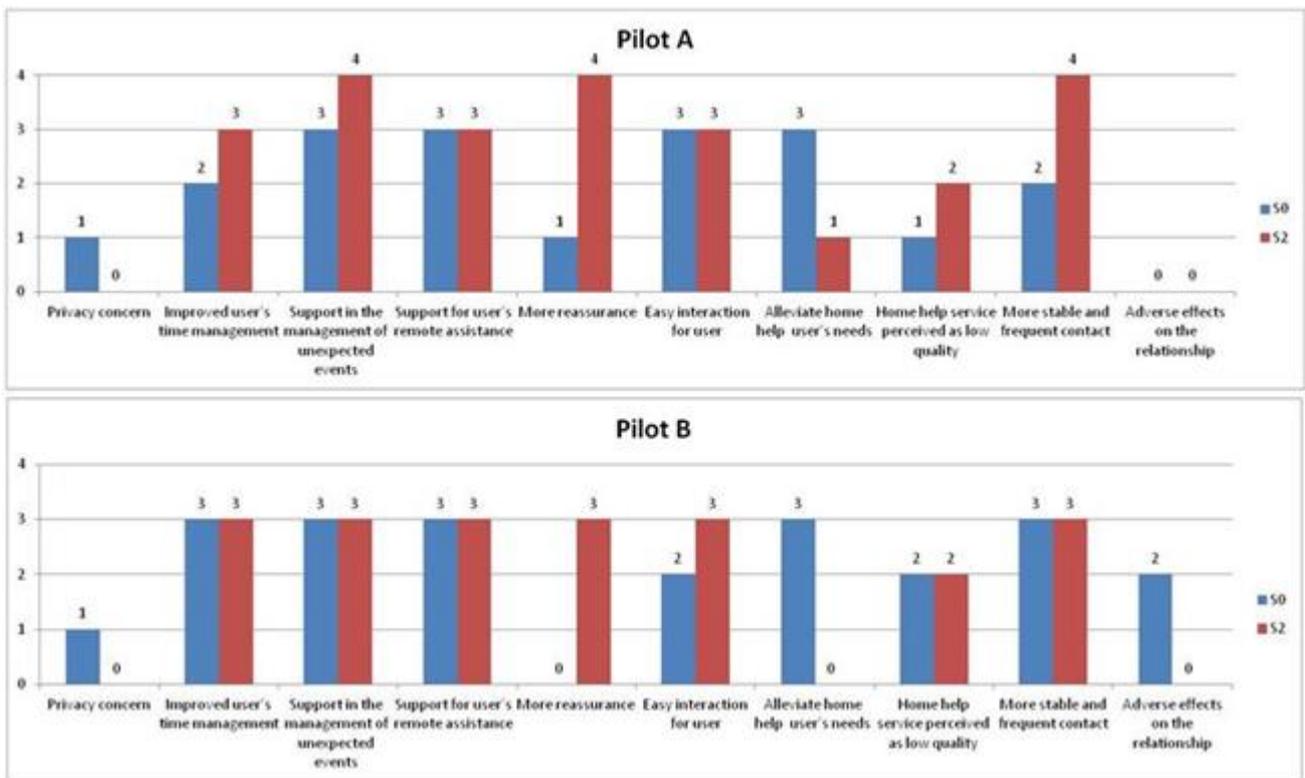
Figure 83: S0- S2 Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system (5 point Likert scale from 0=not at all to 4=very much)
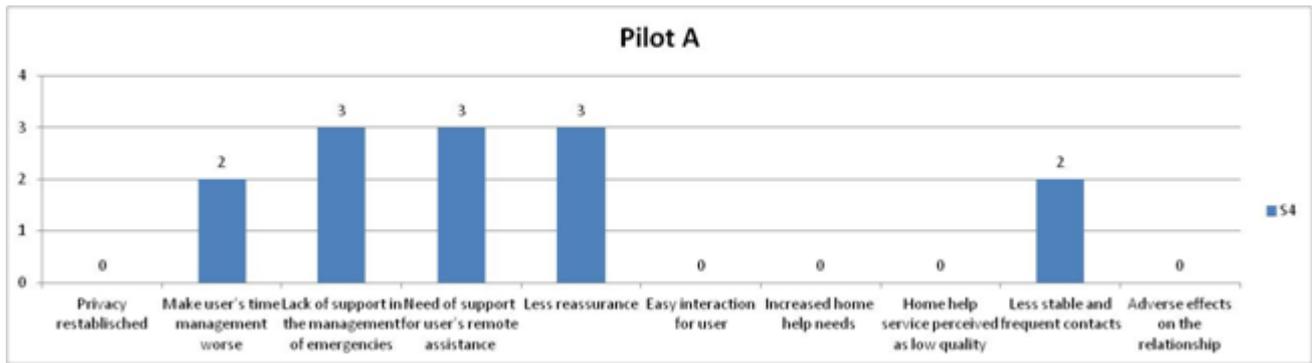
Figure 84: S4 Questionnaire distribution secondary user's responses to expectation assessment related to the adoption of a telepresence system (5 point Likert scale from 0=not at all to 4=very much)

6.4.3.2 System Usability Scale - Ease/Difficulty of learning and use functions' and commands' interface

The analysis of the SUS questionnaire showed a score of 90 for Pilot A indicating a optimal level of subjective usability of the Giraff's client interface. Pilot B has a different perception of usability, her score is 67,5 and it is indicative of a sufficient level of usability.

These result also confirmed by the questionnaire on the usability of the system we developed ad hoc for the case study, which shows higher scores at S1 for pilot A respect to pilot B. Pilot B report lower scores for functions of going backwards, docking, position for docking, navigation and safety of movement (Figure 85 up)

At time S2 (Figure 85 down) both secondary users show some changes in the usability of specific functionalities that gets unsatisfactory over time. Specifically, functionalities as the connection, docking, position for docking, video quality, navigation and safety of movement become more difficult to manage.
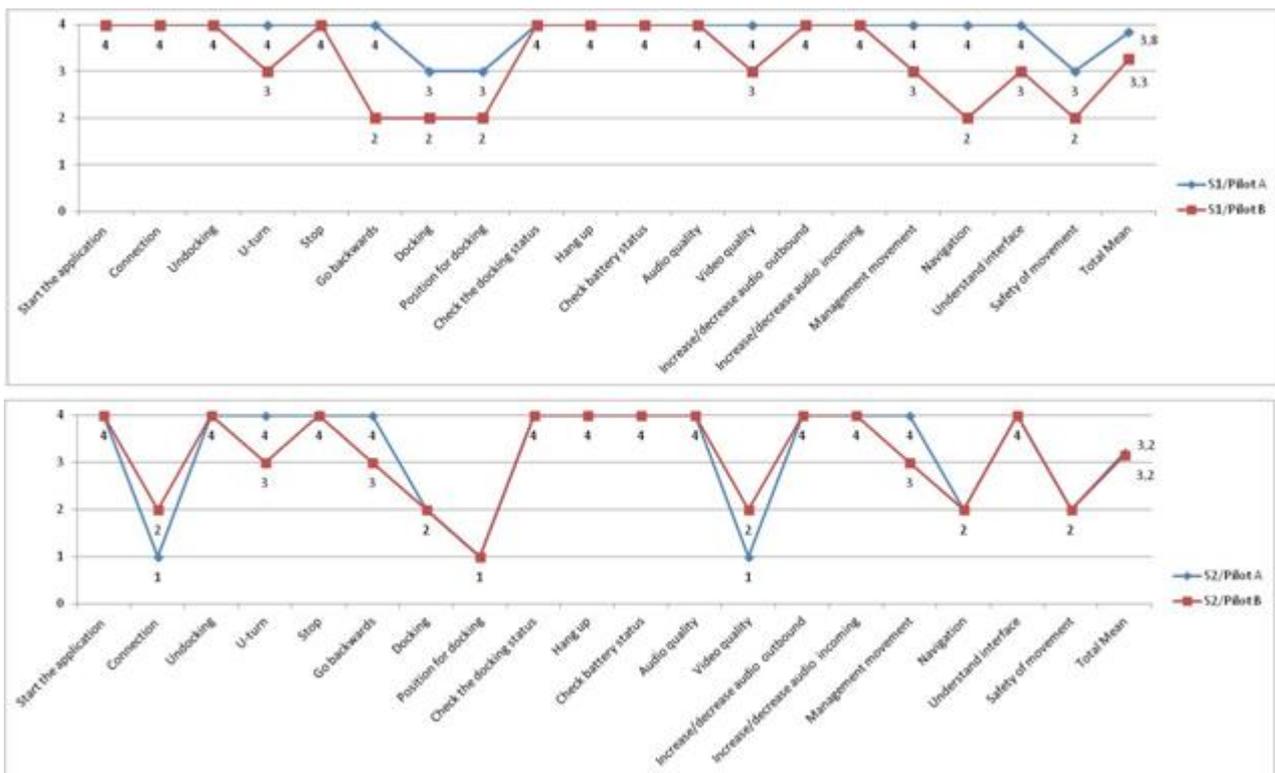
Figure 85: S1 (up) and S2 (down) Questionnaire distribution on pilot response to usability assessment
(5 points Likert scale from 0 = very difficult, 4 = very easy)

6.4.3.3 Telepresence dimensions

Regarding the telepresence dimensions of Temple Presence and Networked Minds Social Presence Inventory (Figure 86) the secondary users perceive the same level of Co presence. They feel moderately a psychological connection to and with end user during the mediated interaction.

Similarly, both secondary user perceive satisfactory level of Spatial presence (sense of being physically located in a virtual environment), Perceived psychological engagement (extent to which the user feel mentally immersed in the experience) and Social Presence (feeling of being together). The perception of Social richness (subjective experience of warmth and intimacy in the mediated Interaction) is very high.

Some differences emerge between the secondary users. Pilot A experiences a greater Perceived behavioral interdependence (extent to which a user's behavior affects and is affected by the interaction's behavior) and Perceptual Realism (experience in which the mediated interaction accurately simulates or reproduces the sensory experience that would be expected in the non-mediated interaction).
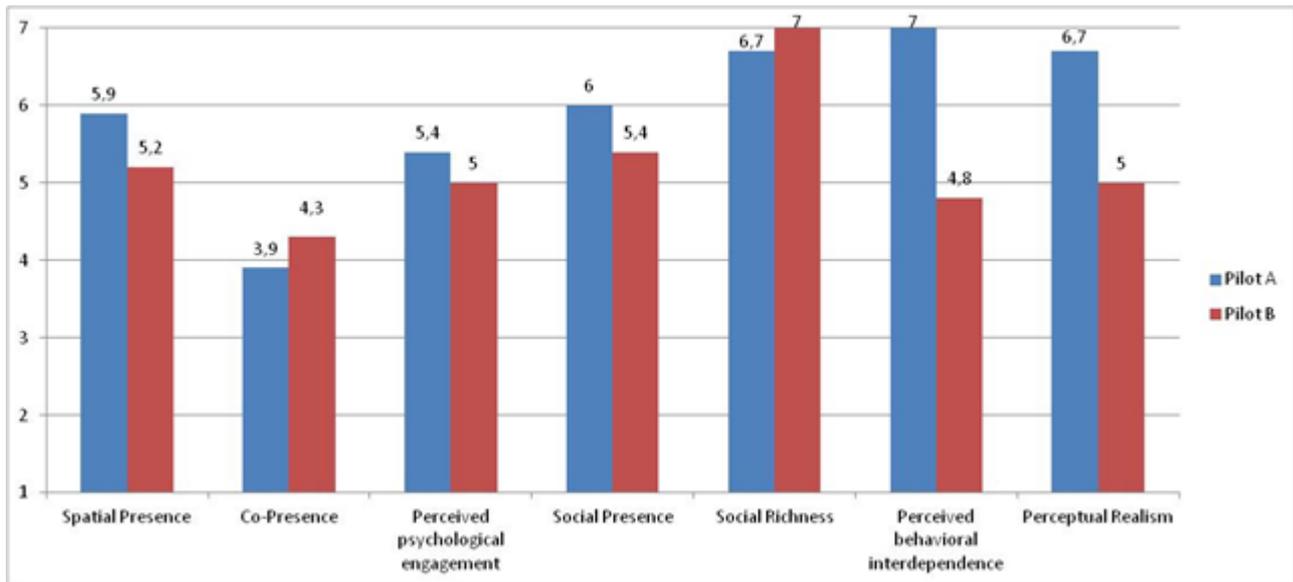
Figure 86: Mean scores of telepresence dimensions for pilot A and pilot B
(7 points Likert scale, from 1= 1 = Not at all to 7= a very high degree)

6.4.3.4 Psychosocial impact of the robot on the end user's quality of life: PIADS scale

Analysis on the PIADS scale reveals that overall the service offered through the telepresence system have a strong psychosocial impact on the secondary users' life (). From the point of view of the three sub-scales of the PIADS it is possible to say that the main improvements have been obtained in Competence for both secondary users (M Pilot A= 2.42; M Pilot B= 2,33). In this respect, a considerable increase is observable in Capability, Skillfulness, Usefulness and Efficiency. For Pilot A, the use of telepresence system has also positively increased the Expertise, Productivity and Independence. For Pilot B, Performance is improved during the use experience with the system.

The pilot A perceives a greater improvement compared to pilot B in terms of Adaptability (M Pilot A= 3 > M Pilot B= 1,5). The use experience with the telepresence system has a strong positive impact in Ability to take advantages of opportunities, Ability to adapt to the activities of daily living, Eagerness to try new things, Ability to participate and Willingness to take chances. Both secondary users perceive a great impact also in terms of Well being.

A slight improvement emerge in Self Esteem for secondary users (M Pilot A= 1.5; M Pilot B= 1,4). In particular, the usage of the system increase users' Self Confidence, Security and Happiness and decrease Frustration especially for pilot B. For this pilot, the impact of system is evident also in terms Sense of power and Performance which are not influenced in Pilot A. Sense of control only for pilot A is affected by the usage of the system.
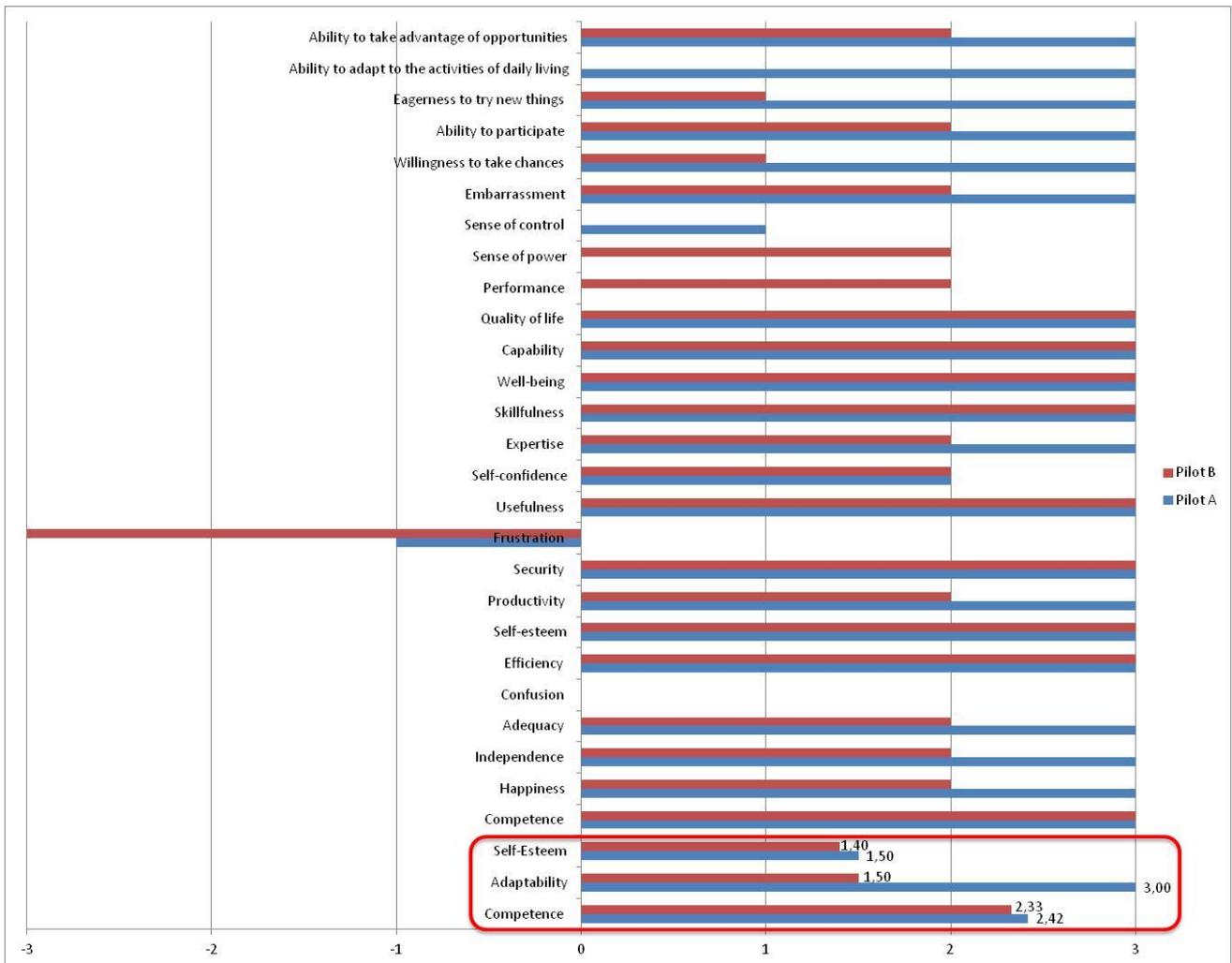
Figure 87: Mean score on three sub scale of Piads distribution of response.
Scale from -3 [Decreases] to + 3 [Increases]

6.4.3.5 Affective state related to the use experience and interaction through telepresence system: PANAS scale

The PANAS scale shows an average value of positive affects for both secondary users (44) toward the Giraff system that is higher than the negative affects scale (Pilot A=18 and Pilot B=15).

6.5 Discussion of the Italian Test Site

The Italian test sited involved 5 older end users and 5 client users.
End users include three females (**F 84yr** [Test Site 1]; **F 77yr** [Test Site 3]and **F 72 yr** [Test Site 5]) and two males (**M 86yr** [Test Site 1] and **M 65yr** [Test Site 4]).
Client users consist of 5 persons, including one family member caregiver, two family members without special caregiving responsibility and two social assistance workers as professional caregivers.

The experience of long-term use of the telepresence system Giraff has been quite satisfactory and heartening for all the test sites and for most of all dimensions investigated in the long term user evaluation.

Below we provide an overall interpretation of the results and differences related to the dimensions of attitude, affective response, robot acceptance, psychosocial impact, usability and telepresence explored and obtained from the point of view of the end users and clients as protagonists of four Italian test sites.

End users side

Perceived social support: Although the perceived social support is always to be read within the context of the life of the individual, in this circumstance it is sufficient to note that generally the family represents the primary source of perceived social support for most of all end users involved in ExCITE project's evaluation. An interesting aspect that emerged in the end users, for which it was possible to investigate this aspect, is related to the variation in perceived social support from significant others during the long term use experience.

Attitude and affective response towards the robot: Overall, the end users' attitude towards the robot is fairly positive in terms of benefits and advantages of the Giraff robot related to their needs. All the end users recruited are certain that the robot is not an element of intrusion into their private home life and they don't perceive any mistrust in terms of psychological distance. Nevertheless, the end users are uncertain about their satisfaction toward robot's features and the burden of management difficulties related to the use of the robot at home. In other word, they do not seem to completely appreciate the functionalities of the robotic telepresence platform and they are doubtful on the concrete ease of management and maintenance of the robot.

Overall, the affective response is rather positive for most of all end users, showing a satisfying experience and pleasurable engagement in the long-term use of the robot at home. An exception may be represented by end users **F 72 yr** [Test Site 5] and **M 65yr** [Test Site 4]. Even though they report positive feelings towards the use experience with the Giraff robot, the scores related to negative affects suggest an ambivalent affective response.

Robot Acceptance: on the whole, the level of functional and social acceptance of the robot show some discrepancies between the end users even as maintaining satisfactory ranks.
The usage of the robot generally does not evoke anxious reactions (ANX) in almost all end users, expect for **F 84yr** [Test Site 1] end user.
Over time, the **M 86yr** [Test Site 1] end user has a very low perceived ease of use (PEOU) unlike the **F 84yr** [Test Site 1] and **M 65yr** [Test Site 4] end users who recognize a good ease of use during their use experience. Conversely, **F 77yr** [Test Site 3]and **F 72 yr** [Test Site 5] end users have a good initial perceived ease of use of the robot which decrease during their long term experience with the robot at home.
End users' attitude toward the daily use of the robot (ATT) is encouragingly positive, with the exception of **F 77yr** [Test Site 3] end user who maintains an ambivalent attitude during her long-term use experience.

Factors in the environment that facilitate use of the robot (FC) are poorly perceived by end users of [Test Site 1], while other end users have a good perception of them.

Over time, **M 86yr** [Test Site 1], **F 84yr** [Test Site 1] and **M 65yr** [Test Site 4] believe that the robotic system is useful (PU) and tailored to their everyday life needs (PAD). They also show a clear intention to use the robot over a longer period in time (ITU). These belief are not found in the **F 77yr** [Test Site 3]and **F 72 yr** [Test Site 5] end users.

Perceived enjoyment pleasure associated with the use of the robot (PENJ) is not clearly perceived by all end users which are indecisive in assessing their sense of pleasure connected with the use experience with the Giraff robot.

F 72 yr [Test Site 5] and **M 65yr** [Test Site 4] end users are persuaded that people who are important to them think she/he should use the robot (SI). This aspect is not significant for end users of [Test Site 1] who don't have perception of Social Influence related to the use of the robot. It 's interesting the point of view of **F 77yr** [Test Site 3] who initially has a high perception of Social Influence that decreases significantly becoming an irrelevant aspect of her long-term experience with the robot.

The belief that the robot performs with personal integrity and reliability (TRUST) emerge only in **M 65yr** [Test Site 4] end user. End users of Test Site 1 don't completely confide in reliability of the robot, while **F 77yr** [Test Site 3]and **F 72 yr** [Test Site 5] leave behind their trust over time.

Psychosocial impact of the robot on the end user's quality of life: considering the end users' perspective the use of the Giraff robot did not have a specific positive psychosocial impact on their everyday life. The main and more evident improvement in relation to the use of robot is on individual willingness to try new experiences and feeling of well-being perceived in relation to the use of robot (Adapatability subscale of PIADS),except for **F 84yr** [Test Site 1] end user who report a very small perceived positive impact of the robot on her everyday life.

A slight positive impact of the robot on functional independence, performance and productivity (Competence subscale of PIADS) is found generally in all the end users, but for **M 65yr** [Test Site 4] end user this improvement is more evident than the others.

End users reported very minimum improvements in terms of impact on their self-confidence, self-esteem and emotional well being (Self-Esteem subscale of PIADS), except for the end users of [Test Site 1] who report more slight marked positive improvements than the others.

Telepresence dimensions: a good and satisfactory subjective experience of warmth and intimacy in the mediated interaction through the robot (Social Richness) is common in all the end users. During the end users' mediated interactions through the robot, feeling of psychological connection to and with another person (Co presence), of being together (Social Presence) and of enjoy (Perceived Enjoyment) have the tendency to vary and be specific to each end user.

Client side

Expectation toward the telepresence system Giraff: referring to the expectation of relative client user with caregiving responsibility of [Test Site 1] , the long term experience confirm or reinforce the individual expectations toward the telepresence system Giraff as a means to support long distance familiar caregiving and to foster social interaction of older adults at home. Overall, the telepresence robotic system Giraff represents an added value for the client user as an aid to:

- alleviate the need of pilot's presence at home

- support in familiar caregiver role and in management of unexpected events
- have reassurance when the pilot is at distance

The point of view of client users of [Test Site 3] and of [Test Site 4] is quite different.

The high expectations of client user of [Test Site 3] toward the telepresence system as support to maintain more stable and frequent contact with her, to alleviate the loneliness of end user and to support everyday communication with the end user, are disappointed.

Client user' expectations of [Test Site 4] are not entirely disillusioned, but during the long term use experience, this client does show uncertainty about the possibility of the system to be a mean to have more stable and frequent contacts with the end user and to support everyday communications.

From the point of view of two clients of [Test Site 5] as professional caregivers, the telepresence system represents over time an added value for them as an aid to:

- potentially improve user's time management;
- support management of any unexpected events and of remote assistance services;
- have reassurance when the pilot is at distance from the end user;
- maintain more stable and frequent contacts.

Usage a telepresence system may not alleviate home help older user's needs.

Neither of the recruited clients believe that the use of Giraff system could have adverse effects on the relationship with the end user nor it could be a threat to the domestic privacy of an older end user.

Usability of the system's interface: the level of subjective usability is very good for client users of [Test Site 3] and of [Test Site 4] and for one of the client users of [Test Site 5]. The remaining client users have a lower perception of interface's system usability, particularly client user of [Test Site 1].

When you analyze client users' all together it is possible to observe how some aspects of usability of the interface's telepresence system are critical to handle for all of them confirming the non-optimal usability of some functions and commands. In particular, not very usable and difficult to operate are the functions and commands relating to:

- wireless connection;
- docking and position for docking;
- video;
- navigation through the environment (especially connected to the stability of wireless connection)

Psychosocial impact of the robot on the end user's quality of life and affective response: The use of the telepresence system has had an impact that shows different discrepancies between the experiences of the Italian client users.

The service offered through Giraff telepresence system had a more strong and positive psychosocial impact on the everyday life of client users of [Test Site 5] in terms of individual willingness to try new experiences and feeling of well-being perceived in relation to the use of the system (Adapatability subscale of PIADS), of functional independence, performance and

productivity (Competence subscale of PIADS) and of influence on personal self-confidence, self-esteem and emotional well being (Self-Esteem subscale of PIADS).

From the point of view of other client users, using the system did not have a specific positive psychosocial impact. In particular, client user of [Test Site 3] report a negative impact of telepresence system in terms of a change in the quality of life of the pilot user specifically on Adapatability and Self esteem related to his use experience with Giraff.

Nevertheless, when you analyze client users' all together it is possible to observe a common positive improvement in willingness to try new experiences and feeling of well-being perceived in relation to the use of the telepresence system.

In terms of affective response, all the client users experienced a very pleasurable engagement in terms of positive affects during the long term use experience, except for client user of [Test Site 1] who shoe doubtful affective assessment relating to the use experience with the telepresence system Giraff.

Telepresence dimensions: Common to all involved client users of Italian test sites is the difficulty to clearly perceive psychological connection to and with end user (Co presence) through the telepresence system. In addition subjective experience of warmth and intimacy in the mediated Interaction (Social Richness) is good perceived in all client users.

Other dimensions are more variable between the client users indicating a very different experience in terms of Spatial and Social Presence, Perceptual Realism, Perceived psychological engagement and behavioral interdependence.

Nevertheless, it is possible to comment that the client users of [Test Site 4] and [Test Site 5] report more high and satisfactory experience of telepresence than client users of [Test Site 1] and [Test Site 3].

7   Additional input from test sites

In this section we give a brief description and discussion of all test sites that followed either a partial evaluation cycle or a different one conceived on purpose. It is important to iterate that many of the recommendations in D2.2 are also stemming from these testsites below.

Sweden Test site 1(a)

The first Swedish test site was deployed in November 2010, that is prior to the set of questionnaires was developed. The end user was an elderly woman living in a house together with her husband. She received assistance from professional home help services daily and she carried a security alarm button. The intention at this intention was that the Giraff would be used as a complement to security alarm. In case of "quiet alarms", the alarm operators from Tunstall should be able to connect to the Giraff. Unfortunately the test site had to be prematurely ended when the woman passed away in March 2011.

Yet, some important feedback was collected at the test site. The alarm operators needed a map to find their way around and the docking station. This issue was resolved by handdrawing a map of the environment and the location of the docking station, print it, and place it at the work desk of the alarm operator. Further, the alarm operators were found to have problems docking the Giraff manually.

Sweden Test site 2

The second Swedish test site was an elderly residential home located in a distant rural area (Töre, north of Sweden). The Giraff was installed in March 2011 while reconstruction work was on going. This was an intentional choice in order to allow for a longer familarization of the robot and to ensure that the robot would be exposed to the tenants. An information trip was made in August 2011. It was found that the intentions of how to use the robot (for meetings between the organization supporting the residential home and the elderly living there) could not be supported by Giraff in the current setup. This was due to the fact that there was a desire to use the robot all over a very large complex consisting of interlinked buildings. While investigations on how to resolve the issue of extending the Giraff range by the use of repeaters gave promising results in Örebro, it was impossible to support a setup of the same system from distance. Therefore, it was decided to end the test site prematurely.

Sweden Testsite 2a

A woman living at Test site 2 showed an interest in having the Giraff in her apartment. Therefore, a researcher from ORU met the woman via Giraff while it was situated in the larger complex. It was agreed that one of the responsibles for the organization supporting the residential home would install a WiFi router within the elderly woman's apartment. However, these attempts were unsuccessful and the decision was made the end the test site prematurely.

Sweden Test site 3

The third test site (and 1b) was a day care center in Örebro. Elderly from around 60-100 who are in need of rehabilitation to maintain or improve their ability to perform activites in order to continue living independently come here 1-2 days per week for a limited time period. Often they have been diagnosed with stroke, fractures and various neurological disorders. While the main expectation

with this test site was to get feedback on the Giraff and communication through it on a group level, the deployment of the Giraff resulted in three other deployments in real homes, test site 5, 6 and 7.

The building itself is not optimal for neither cellular phones nor WiFi networks due to a number of larger concrete pillars. This resulted in frequent network problems and comments such as "you become numb" from the elderly. Sometimes, the connection was cut and the Giraff was left standing in the middle of the room. It is perceived that this may cause a decreased trust in the product.

An additional problem at this test site was an error message, E28. Initially this was perceived to be caused by a drained out battery. While this had been fixed by Giraff Technologies AB, a new problem (Giraff not ringing) which was related to Vsee arose at this and a few more test sites. This made it natural to end this test site. It should also be noticed that Giraff Technologies AB later found that the E28 was a software bug which can now be fixed on spot.

Sweden Test site 5

The end user is a 74 year old man who has had a stroke resulting in residual right-sided weakness. For this reason he walks with a stroller indoors and uses an electrical wheelchair outdoors. He lives with his wife and both of them have are active in club activities and have a social life. Both of them are accustomed to using computers and Skype.

Initial expectations include opportunity to give feedback and evaluate new technologies, an increased security when the woman is away (Tunstall connecting to Giraff) and an opportunity for greater contacts with a son in Portugal and the grandchildren. Additional expectations due to misunderstandings included that the woman would be able to connect to Giraff from her iPad while being in her summer house in a rural area with poor gsm networks and that Tunstall would connect automatically in case the man fell.

From the start of the test site, there were many technical problems which made it difficult for the project team to create the picture of a Giraff that could be used for natural communication. These included a serious bug which caused false positive online messages on the Giraff itself. This was reducing the couple's confidence in the product. Additionally, it was found that the WiFi router from the ISP Comhem was not working perfectly with the Giraff (low range). This WiFi router was replaced with a 5GHz router but did not resolve the software bug. Due to the low reliability, the son in Portugal chose to use the telephone instead of Giraff for communicating with the couple. Additional attempts to find new secondary users (friend and "granddaughter") were made but their motivation of using the robot seemed low.

A common perception of both the end user and the wife is that the product was under development rather than something ready for use. It is believed that filling questionnaires aiming at collecting long-term data on the use of Giraff could not have been done, it is likely that differences in response would not be due to Giraff but other factors.

Comments from the end user during the end interview indicate that the robot is not smart enough: "There is more I would have wanted it to do and you do this in the new project (GiraffPlus)". Yet, the man also said that he preferred interacting via Giraff over the telephone as he can see who he is talking to then. Additional comments include a desire to adjust the ring signal's volume which is perceived to be too loud.

Comments from the wife during the interview show that there was an annoyance caused by a misunderstanding of how to get in touch with Tunstall if the man fell. The woman said "If you have an alarm situation and he hasn't the remote with him then he cannot get help" without considering the possibility to use the security alarm button from Tunstall to get in touch.

Sweden Test site 6

The test site is a 76 year old widow living along in an apartment with her two cats. She is a person who "wants a lot", that is to try out new things but they tire her out quickly. She receives daily help from the home care services and goes to a social daycare center. She has had a few minor strokes. The daughters initially claim that they want to be able to use the Giraff in case the mother doesn't answer the phone, something she doesn't always do even when being home. They also have a desire that Tunstall should be able to connect.

The Giraff was connected to the internet via a 4G WiFi-router. Similarly to test site 5, the deployment is affected by a software bug, the Giraff gives a false online message even when being disconnected from the internet.

Further, the woman herself and also the cats sometimes caused the Giraff's battery to drain out. Although she could push the Giraff back into the docking station while instructed on the phone, this was an ongoing problem.

It was decided to remove the Giraff when there was no natural pilo user, the daughters who initially claimed they wanted to connect felt uncomfortable while doing so. The woman was not disturbed by having a Giraff, the problem was that noone wanted to connect. However, she was afraid of running into the WiFi stick and would have preferred to be able to put the Giraff away in a "garage".

It is believed that filling questionnaires aiming at collecting long-term data on the use of Giraff could not have been done, it is likely that differences in response would not be due to Giraff but other factors.

Italy Test site 2

The study of the robot as a system of rehabilitation at a distance of healthy elderly persons or patients with mild cognitive decline represents an attempt to structure a research protocol aimed at validating the use of telemedicine as a robot for a specific class of users older. The research is based on the use of objective and subjective feedback to study the influence of the presence of the robot. The combination of objective and subjective measures proved to be an extremely valuable approach for better and more complete understanding of user response to a possible use of telepresence robots in the field of cognitive rehabilitation.

The results of this study show a general trend of the sample recruited to well tolerate the presence of the robot during the cognitive stimulation task. In terms of cardiovascular response, no significant difference emerged in the response of the heartbeat between the control group and the one with mild cognitive decline during the interaction with both the human experimenter and with the robot.

However, a thorough analysis of Heart Rate Variability detects a significant difference in the degree of variability of the heart rate, the lower for the group with mild cognitive decline in the interaction with the robot. This result may indicate a lower tendency of the participants to adapt to the presence of the robot during the performance of cognitive stimulation.

Referring to the data obtained by the subjective self-report measures, the interaction with the robot does not generate any state of anxiety in both groups of participants. Similarly, there is a prevalence of positive affects for both groups during the interaction with the human experimenter and subsequently with the robot. In terms of social presence, the data obtained from the final

interview reveal that 94% of the sample recruited felt physically involved during the interaction mediated by the robot. Among the benefits identified, 72% of the subjects stated that the robot would help them to feel more secure at home if circumstances arise of disease and disability. Finally, the majority of participants (88%) thought the robot is nice to see.

For a detailed discussion of the procedure and the results of this study please see (Tiberio et al., 2012).

8 Summary of the evaluation results and Conclusions

This deliverable has presented the collected data from all the testsites in Europe. Above all, test sites allowed the collection of useful feedback obtained in relation to the technical aspects of the system that was translated into technical recommendations for the developers and inspired the iteratively improved versions of the telepresence robot. In addition to this, each country provided a summary of their running testsites against comparable parameters and data related to other aspects e.g. presence dimensions, psychosocial aspects, usability, attitude, acceptance, impact on life, privacy, etc. For testsites that had additional or other observations, a summary of these has been provided together at the end of the deliverable.

Despite the heterogeneity of the users and different situations in which the Giraff robot has been tested, a few general remarks about the evaluation can be made. First, *telepresence* is high in general for the testsite users and this is not so surprising since they are immersed in their own environment with the possibility for mobility and very much a "host" to the one connecting. This means that the concept of allowing the client user to be in control and be embodied by the Giraff is indeed an appreciated one from the point of view of the primary user. However, from the secondary user, who is confined to the screen and web cam, we see that the sense of presence is much lower in relation to many of the dimension measured by the questionnaire. This point has translated into a set of heavy recommendations to improve audio quality, to improve control and usability of the interface and to improve video by adding both hardware and software features. Still however, it is important to determine if it is the technology per se which hinders telepresence or the media – that is to say, the fact that the clients are usually at a desktop or laptop. One direction of further scientific study would be to consider client users with other devices such as an ipad or a mobile to see if that changes their feelings along the telepresence dimensions. Nevertheless, being "hands-free" as the primary end users are is beneficial perhaps not only to an elderly group but to all users of remote telepresence devices.

Another remark concerns *acceptance*. Robotic acceptance for all testsites is either maintained or lowered – it does not increase. This is most likely tightly interlinked with expectations and also the diminished novelty of the unit over time. Though, further study is needed to ascertain exact causes, the fact that a longitudinal exposure to the robot does not increase acceptance of the robot is an aspect to consider in the development of the product and possible new features.In addition, it is worth highlighting that acceptance is also dependent upon the perceived utility and to adaptiveness of the system (capability of the system to adapt to different needs). In some cases the instability and the technical problems of the system may have had a negative impact on both adaptiveness and acceptance. It should be noted however that a lack of increase, does not necessarily imply that acceptance was low for all persons

It is also worth pointing out that for the most part the robot did not evoke anxiety for the users.

Psychosocial impact of the robot on end users was in general higher for the secondary users than the primary end users. For the (secondary) client users, contact is typically initiated by them, meaning that they make the call to the Giraff unit. A psychosocial impact also reaffirms many of the technical recommendations, as these recommendations emerged from a positive experience and willingness from the users.

Also from a cross-cultural perspective we know that social exclusion in old age widely varies across the EU and the lowest share of social exclusion can be observed in EUs Nordic countries. Additionally, social exclusion is also linked to chronic diseases (both objective as well as self-perceived) and/or being in need of care, environmental factors and family status and family relations. In this respect Swedish end users of our test sites had better level of health with respect to the Italian and Spanish who also reported higher level on loneliness. Clearly, an additional concentrate study with even different questionaires would be necessary to do a true cross cultural analysis. In ExCITE the users evaluations have reiterated that that certain factors (e.g., in Sweden most users were care organizations) are important to consider and in particular to bring into the business model of the company.

In sum, the feedback collected from the long-term field trials in the homes of older people emphasizes how important it is to understand the possible gap between the characteristics and needs of the person and the functionality of a technological aid as Giraff, in this context used as a means to limit the sense of loneliness and social isolation. Our experience confirms firstly the importance of knowing and always considering the role of age-related changes and their trends over time.

Changes that affect the state of physical and mental health of an elderly person can certainly have affected the way in which our end user interacted with the robotic aid, their willingness to accept over time the Giraff at home and make the most of in their daily routine.

Social acceptance and functional robot is so closely linked to the heterogeneity of individual needs, the subjective perception of the need for assistance, the social inclusion and living conditions of the specific person.

In general, Giraff appeared to be a good means of communication that conveys a nice sense of warmth and intimacy for the testpersons involved in the fully evaluated testsites.

Another important aspect considered in the study was the perceived *privacy*, which seems not affected by the Giraff system.

Overall the testpersons did not feel invaded their privacy by the Giraff presence and this is also confirmed over time. This means that the robot is generally not perceived and an element of intrusion in the old person's life.

The experience of use of the robot has been satisfactory and interesting, though not fully engaging for the end users. People over time have tended to show a benevolent attitude towards the robot and its daily use. However, the use of Giraff did not have a decisive impact on the quality of life of the end users. It is not unlikely that the technical difficulties impacted this parameter, nor can it is possible to rule out the possible novelty effect. Still, the potential benefits and advantages of using telepresence seem to be recognized and appreciated. Giraff is still a prototype and though the robot does not fully meet the user from the point of view of functionality, which are perceived somehow limited and static, the effort of ExCITE has been to find the technical shortcomings and address them.

Features have been sometimes partly perceived as unstable and unreliable from a technical point of view and this consequently affected the confidence of users, but also the perceived ease of use and therefore the ability to interact effectively with and through the proposed aid. This is a valuable lesson that emphasizes the challenge of testing with prototypes in the field, particularly prototypes that are used longitudinally as there are many technical dependencies in a system as complex as the Giraff. In some cases this could also be due to the limitations introduced by the quality of the Internet service. Also, different individual have varying tolerance to technology failing and these thresholds are perhaps lower in an older population.

> **The ability for users to take advantage of a constant technical support for the maintenance of the robotic platform was important for the acceptance and the intention of long-term use.**

Overall, the robot generates interest and curiosity, and a subsequent phase of evaluation with the final robot obtained after including the various user feedback in terms of additional features and improvements would be extremely interesting to perform.

Furthermore, from the client users' point of view, the experience of long-term use of the telepresence system Giraff was for the most part pleasant and interesting. The expectations toward the use of the telepresence system as an aid to alleviate older persons' loneliness and social isolation are not fully met for family members. This specific class of users recognizes the importance of being able to make eye contact with the end user via the telepresence system, but they do not have the perception that this may be an effective way to maintain stable and frequent contacts and to relieve the older persons' loneliness and social isolation. However,

> **the telepresence system Giraff is quite appreciated by client users who have the role of caregiver (relative or professional**). **The expectations toward a system that may potentially provide a social assistance having a service or remote monitoring support role are confirmed during the users' long-term experience.**

It is likely that the telepresence system's features and functionalities have met the tasks and responsibility of a client user in the role of relative or professional caregiver. This aspect may certainly have influenced the client users' usefulness perception of the telepresence system and the extent of the impact on their quality of life related to their caregiving duties toward the end user. Critical aspects of usability of some functions and commands may have had an impact on

usefulness perception and on the perception of Giraff as a means to improve their quality of life with respect to their caregiving duties toward the end user. In addition, wireless connection problems encountered especially in Italy and Spain, may have influenced the overall attitude of the client users especially with respect to the perceived usefulness and reliability of the system.

The results presented from the tests above are complex and non-trivial to analyze. Clearly, having a much larger number of testsites would provide the ability to confirm particular hypothesis between specific technological features and their impact on the users. Nevertheless, the examination of one individual over time and changes to particular parameters has been extremely insightful. ExCITE has taken on a bold challenge of putting robotic technologies in homes at a prototypical stage and attempting to maintain them over time. Given that the Giraff system is rather complex in terms of the amount of modules, components, software systems and interdependencies, the technology has truly undergone user driven design.

As mentioned above, the long-term assessment allowed gathering useful feedbacks obtained through which it was possible to derive many technical recommendations for the technological refinement that led to the development of a complete new prototype.

> **The final product of the ExCITE project is a new robot that includes many of the recommendations emerged from the long-term experience that could have not been derived from short-term exposure to the teleprence platform.**

We think that the new version of the robot and the increased level of robustness and stability would clear be beneficial for a new evaluation of the mentioned aspects, solving most of the perplexities emerged during this long term assessment.

> *Finally, the last concluding remark is an acknowledgement to the testsite end users in ExCITE. Without their support this project would not have been possible. The ExCITE team had the pleasure to build good relations with many users. This deliverable is dedicated to the ones we knew, the ones we lost, and to all we learned from.*

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