

# ICT Systems and Services for Ageing Well: Identification and Assessment of an Important Set (Package) of ICT Services for Active Ageing and Independent Living

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**Abstract—** Currently, the main care model for supporting elderly people living alone at home is based on informal and formal caregivers assistance. Considering the demographic changes of older population, which increases rapidly, this model is expected to pose major challenges both in the economy as well as the society. To address these challenges, there is growing attention for assistive technologies to support seniors stay active and independent, for as long as possible, in their preferred home environments. ICT systems for Ageing Well are among those initiatives. The work presented in this paper is based on the context of the Miraculous-Life project. It focuses on the identification and assessment, in terms of usefulness, technical feasibility and constrains, of a set (package) of services that an ICT system for Ageing Well should support. The results extracted from our study and provided in this paper can be considered by other projects working in the area of Ageing Well and assist the consortium to gain an insight about i) which ICT services can provide the greater benefit to the elderly and their caregivers' QoL, and thus reduce time and resources needed to be allocated for identifying, from scratch, the services that will be supported by their system, and ii) the technical perspective of the ICT services and prioritize their development, as well as, facilitate better allocation of their resources, to minimize any risks that could result in failure to implement these services in the framework of their project.

**Keywords—** ICT services, Wellbeing, Ageing Well, Independent Living, Active Ageing.

## I. INTRODUCTION

By the year of 2050, it is projected [1] that, the number of people in Europe aged 65 and above, is expected to grow by 70% and the number of people aged over 80 by 170%. Moreover, improvements in welfare and medical care will allow life expectancy in Europe's population to increase, which is of course a positive result, however without necessarily meaning that living longer implies a healthier, more active and independent life [2].

The main care model currently used for supporting elderly people living alone at home, is based on informal (i.e., relatives, friends, etc.) and formal (care professionals) caregivers assistance. Considering the demographic changes of older population, which increases rapidly, this model is expected to pose major challenges in the near future, both in the economy as well as the society, for: i) meeting the higher demand for health care, ii) adapting health systems to the needs of an ageing population while keeping them sustainable in societies with smaller workforce, and iii) having an older but healthy workforce since younger people will have to work longer to relieve the financial burden on society.

To address these challenges, there is growing attention for assistive technologies to support seniors stay active and independent, for as long as possible, in their preferred home environments. Information and Communications Technologies (ICT) for Ageing Well are among those initiatives offering services related to the support of independent and active living, monitoring and maintaining safety and enhancement of health and psychological well-being of elders.

The work presented in this paper is based on the context of the Miraculous-Life project [3] and focuses on the identification and assessment of a set (package) of services that an ICT system for Ageing Well, that promotes 'Positive Ageing', should support. 'Positive Ageing' seeks to take a balanced approach between addressing the opportunities and challenges of an ageing society rather than seeing the increase in longevity as a burden and a threat. Elderly and caregivers from two end-user organizations were involved in this study, MRPS in Geneva (Switzerland) and ZUYDELAND in Sittard (The Netherlands), that assisted us to identify and analyse the usefulness and the impact that these ICT services can have on their Quality of Life (QoL).

## II. ICT TECHNOLOGIES AND AGEING

ICT technologies are being taken up by the market as health and social care profitable solutions in terms of deliv-

erance and efficiency [4]. These technologies can be used and support older people: i) at work, by enabling them to stay active and productive for longer and experience better quality of work and work-life balance, ii) in the community, in overcoming isolation and loneliness, keeping up social networks and accessing public and private services, and iii) at home by offering them a better QoL for longer, and promoting their independence, autonomy and dignity.

Using ICT technologies to face the challenges and opportunities of ageing societies in Europe has been a target of research of different groups and with a strong support from the European Commission. One major research branch is how the application of ICT can respond to the needs of an ageing society and make key contributions to an independent and prolonged living of elderly people in their home environments. When it comes to the design and development of ICT services for independent and active living [5], the specific needs, disabilities and requirements of the elderly users have to be highly considered as well, so as to ensure and guarantee accessibility and usability (e.g., due to their limited ability to hear, see or to control ICT devices). Also, the non-homogeneous group of the elderly people (as they differ by age, sex, degree of impairment, biography, income, education, religion, culture, etc.) and their expectations regarding technology have to be taken into account.

The aforesaid constitutes the motivation for the present study, which aims to identify and assess a specific package of ICT services, supporting a diverse set of services ranging from social daily activities to leisure, education, guidance, physical exercise, medication and safety services, and demonstrate their importance and impact on the QoL of both the elderly people and their caregivers. The results of this study are presented in chapter III and IV, respectively.

### III. IDENTIFICATION OF AN IMPORTANT SET (PACKAGE) OF ICT SERVICES FOR AGEING WELL

During the framework of our study, a task of significant importance was to first identify and understand what are the specific problems, needs and demands of elderly people, regarding active and independent living and identify which ICT services can provide the greater benefit to the elderly and their caregivers' QoL. To achieve this, the requirement analysis process was performed in two rounds (Fig. 1) and information collected from several sources was considered.

During the first round, a literature study was performed that allowed us to obtain useful information from previous projects and research studies appeared in the open literature. This information was considered as a starting and guiding point for discovering the link between the elderly and the use of ICT-based services and technology, how these can assist the elderly community regarding their independent

living and self-management and understand the general users' needs and requirements on assistive living and ICT technologies. Furthermore, continuous communication and involvement of elderly and caregivers end-users from two end users organizations, MRPS and ZUYDELAND, was crucial for realistic information gathering. Thus, in addition to the literature study performed, questionnaires were also developed and circulated to the all the end-users. The data collected by these two information sources revealed the specific problems, needs and demands of elderly people, regarding active and independent living, and a first set of ICT services, addressing them, were identified.

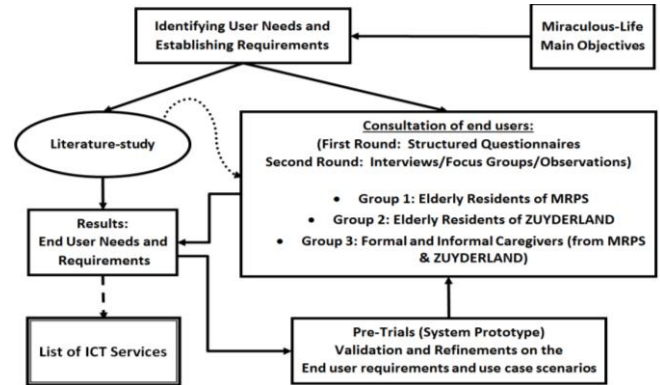


Fig.1 User Needs Analysis Process Followed

In addition, especially important were also the well-structured interviews and focus groups with the elderly and the formal and informal caregivers, that have been applied during the second round of the requirement gathering process (after having the end users interacting with the system; First Pre-Trials), for refining or defining any new needs and requirements that were missed during the first round. This final set of requirements was translated into functional specifications, and a list (package) of twenty (20) ICT services, described in Table 1, were identified as important for every ICT system for Ageing Well, to support.

Table 1 Package important ICT Services for Ageing Well

Service	Description
S01. Contact Assistance	Assists the elderly to create and maintain a contact list of their friends/family/neighbours/caregivers/etc., view their contact details to call/skype/email and facilitate them to establish a call/skype or send an email.
S02. Messaging	Enables the management, organization and communication of messages between the users. It facilitates communication (send/receive messages either by SMS, email or simple messages), between the elderly, his/her friends /family/ neighbours/ caregivers/ etc., and other users of the system.
S03. Shopping	Assists the elderly to create (by adding or removing items) a suitable shopping list and send the list to the (informal) care-

Assistance	giver to buy the missing items.
<b>S04.</b> Medication Service & Reminders	Provides medical information related to a specific elderly. In particular, it provides personal details of medicine associated with an elderly such as name, description, dose, frequency that a medication should be taken and route of medicine. Based on these information the system reminds, at a set times, the elderly to take his/her medication.
<b>S05.</b> Wake-up Calls	Assists the elderly to set the wake up alarms at a specific time they want to wake up (can be set for a day, weekends, weekdays, etc.) and trigger the alarm clock at the specified times.
<b>S06.</b> Periodic Advice	Periodic advices are notifications (written by caregivers, or receptionists, or animators) that are periodically provided to the elderly by the system responsible to provide advices/guidelines that will improve the health of the elderly. For example, every four hours during a very hot day the following periodic advice can be provided: "Dear Nicole, the weather has been so hot lately. It's important to stay adequately hydrated. Don't forget to drink a glass of water from time to time, even if you don't perceive it necessarily".
<b>S07.</b> Fall Detection & Alerting	Detects a fall event of the elderly and alert the appropriate persons (emergency contacts) in case of need.
<b>S08.</b> Dangerous Objects Adviser	Detects dangerous objects, for example on the floor that could potentially cause a fall. When a dangerous object is detected the system warns the elderly for obstacles, reducing the risk of fall.
<b>S09.</b> Dangerous Situations Adviser	Reminds and warns the elderly of dangerous or highly risk activities/situations that can result in injury. For example if the system detects that the elderly is preparing a meal, after cooking it reminds him/her to switch off the stove/oven.
<b>S10.</b> Call for Help & Alerting	After a "Call for Help" voice command from the elderly, the system alerts the appropriate persons (emergency contacts) in case of need.
<b>S11.</b> Windows Monitoring	Monitors the windows and reminds the elderly, after they wake up in the morning to open the windows for having fresh air, and close the windows before they go to bed, if the elderly forget it.
<b>S12.</b> Go to bed reminder	Detects if the elderly is not in the bed during the night. If the user is not detected in the bed, the system suggests him/her to go to sleep (at a set time based on his daily pattern).
<b>S13.</b> Agenda Service	Keeps track of certain activities related to an elder. In particular, it provides details regarding agenda items that an elder should consider and/or attend. Also, the elderly can create social activities and invite friend or relatives to join activities.
<b>S14.</b> Event/Group activities	Provides information about events or group leisure activities organized by the institution or in the city, which the elderly can consult and subscribe to participate. It also allows the elderly to invite other members to participate.
<b>S15.</b> Appointment reminder	Reminds the elderly of his/her appointments (e.g., medical appointments, social events) and pre-scheduled activities before the events begins (e.g., time of activity, location of activity, accessories they might need, etc.).
<b>S16.</b> Object Location Assistance & Reminder	Assists the elderly on locating "forgotten" objects at home, with the help of sensors, and help them retrieve them. If the system fails in locating the object lost, it will provide reminders to the elderly where they normally put their personal items so that they can find them easier
<b>S17.</b> Notifications	Notifications are a general group of messages (written by caregivers, receptionists, animators, etc.) that are provided to the elderly by the system. For example: "Mr. Smith has recently moved in your location area... and he is your new neighbour! Why not invite him for a coffee?" or "There is a package

	at the reception for you. Please go and get it.", etc.
<b>S18.</b> Meal preparation Assistance	Responsible to provide information regarding meals, their recipe, the ingredients of a meal, and assist/teach the elderly to prepare the meal, by providing oral guidance. Also the recipes provided to the elderly by this service consider the dietary requirements and allergies of the elderly (e.g., recipes that contradict with the dietary requirements or include ingredients that the elderly is allergic to, are excluded).
<b>S19.</b> Motivation for Physical Activity	Detects, based on information logged in in the system, if the elderly is not performing sufficient physical activity, and motivates him/her, based on his profile (e.g., physical activity preferences, health status, disabilities, etc.) in performing physical activities/exercises.
<b>S20.</b> Physical Activity Service	Guides the elderly during undergoing their physical exercises. For example the elderly can watch short video clips demonstrating physical exercises that he/she can perform at home (note that a list of physical exercises is selected and associated to the elderly by a physiotherapist, based on his/her profile (e.g., preferences, health status, disabilities, etc.))

#### IV. ASSESSMENT OF SELECTED ICT SERVICES: USEFULNESS, IMPACT AND TECHNICAL PERSPECTIVE

After the first pre-trial and benefiting from having the technical partners dealing with the development of the services (and thus having the opportunity to identify any risks or technical constrains) and the end-users interacting with the system (and thus understanding the usefulness and impact that these services can have in their life), in order to provide a better assessment of the ICT services listed above, we considered: i) a relevance analysis of the services to evaluate their benefit (usefulness and impact) on the end users QoL and ii) a technical perspective to understand the technical feasibility, technical constrains and the risks (and thus the "cost") related to their development.

With respect to the benefit evaluation of the services, a user questionnaire was built and administrated to MRPS and ZUYDERLAND caregivers and professionals in order to evaluate the usefulness and the impact that the 20 ICT services, identified in Table 1, can have on both the elderly and the caregivers QoL. Participants were asked to rate each service by using a 10-points Likert scale (1 = Not Useful; 10 = Essential). Similarly, the same questionnaire was utilized to obtain this information from the elderly of both end-user organizations. The MRPS group, participated in this analysis, included seven (7) elderly people and nine (9) caregivers (1 nursing auxiliary, 3 animators; 2 nurses; 2 members of the "resident service" team; 1 care coordinator) while the ZUYDERLAND group included seven (7) elderly people and the fourteen (14) caregivers (4 carers; 4 nurses; 3 policy advisors; 2 animators; 1 project manager).

The results collected, providing the ranking and the impact analysis of the identified ICT services according to the participated caregivers and elderly population, are provided in Table 2 and Table 3. To provide a better understanding of

the results of this assessment, the results are also compared in Fig. 2. It is apparent that the tendency curves of both the elderly and caregivers have a strong similarity. Thus, it becomes clear that both populations have the same relative opinion of the usefulness of the services. However, a deviation on the mean values is identifiable which could be excused by non-homogeneous and the different nature of the groups of participating populations (caregivers and elderly).

Table 2 Ranking of ICT Services based on their usefulness (1=Not Useful; 10=Essential) - Both end-users organizations (Caregivers=25, Elderly=14)

Caregivers			Elderly		
Service	Mean	STD	Service	Mean	STD
S10	9.52	0.71	S10	8.11	1.42
S07	9.32	0.90	S07	8.00	2.48
S04	8.84	1.34	S08	7.57	2.68
S01	8.64	1.22	S05	7.11	2.10
S09	8.60	1.50	S15	6.89	2.66
S15	8.60	1.12	S09	6.61	3.20
S14	8.56	1.16	S20	6.46	2.42
S02	8.20	1.76	S06	6.39	2.35
S08	8.20	1.66	S16	6.39	3.41
S13	8.16	1.75	S04	6.25	3.00
S16	7.88	1.69	S13	6.25	2.28
S17	7.84	1.95	S17	6.18	2.52
S03	7.71	1.78	S14	6.11	2.29
S06	7.68	2.12	S01	6.07	2.50
S05	7.60	1.83	S02	5.89	2.70
S11	7.12	1.88	S19	5.89	2.96
S19	6.88	1.94	S03	5.61	2.53
S20	6.84	2.08	S11	5.25	2.56
S12	6.68	2.12	S12	4.04	2.27
S18	6.56	2.20	S18	3.82	2.41

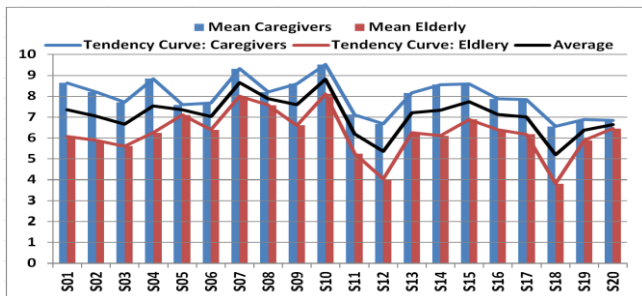


Fig. 2 ICT Services Assessment based on their usefulness (1 = Not Useful; 10 = Essential)

Table 3 Impact Analysis of ICT Services on elderly and caregivers QoL - Both end-users organizations (Caregivers = 25, Elderly = 14)

**Impact**

**S01:** Increase the elderly social interaction, preventing loneliness and isolation, contributing thus positively to their wellbeing. Facilitates establishment of phone/skype communication improving highly the efficiency and continuity of integrated care provision to the elderly at

home, resulting in reduction of demand of care resources and burden of care from the caregivers.

**S02:** Similar to S01. Also, it promotes collaboration, between the elderly and formal/informal caregivers, in order to better and more efficiently assist the elderly and support him/her through his/her daily activities.

**S03:** Assist the elderly to remain longer active and independent in their home environments. The elderly maintain their social interactions with their informal caregivers and/or friends who volunteered to do the shopping for them. Reducing care burden since the shopping will be done by an informal caregiver.

**S04:** Allows the elderly to feel more independent by managing his/her medication intake on time which prolongs the period the elderly stays at home. Improves safety in elderly Health Care, reducing care burden, care stress and workload by the formal and informal caregivers, since they only have to attend the elderly in case the system notifies them (e.g., in case the elderly is refused to take his/her medicine).

**S05:** Prolongs the autonomy and independence of the elderly, providing the opportunity to set up his/her own wake-up calls. Stimulates the elderly to start an active day rhythm on his own pace. The caregiver does not have to attend and worry about waking up the elderly.

**S06:** Ensures the elderly is advised to keep healthy and active, improving thus their QoL. Keeping healthy also promotes an active lifestyle for the elder and prolongs their autonomy and independent living, which results in reduction of demand of care resources and burden of care.

**S07:** Improve Safety and Quality in elderly Health Care, prolonging their life in their home environments and thus delaying inclusion into care centres. The elderly feel protected and cared for, thus motivated to continue their active life at home. Reduces care stress, demand of care resources and of the burden of care by the caregivers.

**S08:** Similarly to S07.

**S09:** Similarly to S07.

**S10:** Similarly to S07.

**S11:** Improves healthy leaving thus preventing a possible health hazard, prolonging the elderly's life in their home environments. Facilitates elderly's independence and reduce care burden from caregivers.

**S12:** Motivate the elderly to sleep on the bed, improve thus both, quality of sleep and autonomy that can have a direct effect on everyday activities. Stimulate independence and reduce care burden from caregivers.

**S13:** Motivate the elderly to remain active and independent by facilitating social interaction, preventing thus loneliness and social isolation. The elderly can organize their life and free time better, improving thus their autonomy, independence and confidence.

**S14:** Motivate elderly in participating to group activities/events, encouraging them to get socially involved and prevent loneliness and isolation as well as early capability degradation by keeping the elderly active.

**S15:** Prevents forgetfulness, allowing the elderly to feel autonomous, active and competent. Motivates the elderly to remain active, by attending planned events and activities. Stimulate independence of elderly and reduce care burden and care stress in formal and informal caregivers.

**S16:** Elderly feels empowered by having assistance to locate items in their household. This motivates them to continue with everyday activities and not feeling demotivated. Independence is also promoted since they do not need to ask for help from formal/informal caregivers. This results in reduction of the demand of care resources, care stress and of the burden of care by the caregivers.

**S17:** Improves the autonomy of the elderly informing them about certain situation and allowing the elder to decide for the action to be taken. Stimulate elderly independent life and reduce care burden and care stress in formal and informal caregivers.

**S18:** Promotes healthy leaving, helps elderly to remain active and have autonomy and independence with respect to their dietary requirements. The elderly can thus be energetic and remains active for longer at home.

**S19:** Stimulate and motivate elderly in performing physical activities. Physical activity helps elderly keep fit, continue performing his daily

activities and prevents early degradation of skills and capabilities.

**S20:** The elderly is provided with a specific set of physical exercises, suitable for their capabilities and potentials. Thus, they are not getting demotivated or possibly injured by attempting activities that they cannot perform. Also, it allows the elderly to select from a predefined list of physical exercises, therefore exercises that they like and that can improve their confidence.

To assess the technical perspective (e.g., identification of technical contains and risks that might appear during development) and understand the technical “cost” of each service (i.e., the more the technical constrains or risks identified, the more the resources will need to be allocated to overcome these), the technical partners involved in the development provided an analysis based on four (4) aspects:

1. *Score of Technical Feasibility:* Using a numerical classification of the technical feasibility of a service it became possible to have clear empirical perspective of the cost of the service. The scale for this assessment is:
  - Excellent (5): Feasible with not any shortcomings.
  - Good (4): Feasible but a small number of minor shortcomings are present.
  - Medium (3): Feasible but a number of shortcomings are present.
  - Fair (2): Maybe not Feasible. Significant shortcomings are present.
  - Poor (1): Not Feasible. Serious inherent shortcomings are present.
2. *Risk Assessment on achieving the service objectives:* Using a simple scale of None, Low, Medium or High.
3. *Risk Explanation:* If risks are identified on achieving the service objectives, these risks are described.
4. *Risk Mitigation:* If risks are identified on achieving the service objectives, mitigation actions that will be enabled if needed, are described.

The technical perspective analysis of each service is presented in Table 4. Moreover, to make an overall assessment of the benefit and the Technical Feasibility, which is highly related to the cost (allocation of MMs) required for development, of the ICT services identified, Fig. 3 is provided.

Table 4 Technical Perspective Analysis of selected ICT Service Package

Ser.	Technical Perspective Analysis
S01	<b>Score of Technical Feasibility:</b> 4, <b>Risk Assessment:</b> Low, <b>Risk Explanation:</b> Technical difficulties may occur when developing the phone line based dispatching technology, <b>Risk Mitigation:</b> Use of existing cloud based dispatching services (e.g., Nexmo.com).
S02	<b>Score of Technical Feasibility:</b> 5, <b>Risk Assessment:</b> None,
S03	<b>Score of Technical Feasibility:</b> 4, <b>Risk Assessment:</b> Low, <b>Risk Explanation:</b> Minor technical difficulties may occur when developing the phone line based SMS service, <b>Risk Mitigation:</b> Use of existing cloud based SMS services (e.g., Nexmo.com).
S04	<b>Score of Technical Feasibility:</b> 5, <b>Risk Assessment:</b> None
S05	<b>Score of Technical Feasibility:</b> 5, <b>Risk Assessment:</b> None

S06	<b>Score of Technical Feasibility:</b> 5, <b>Risk Assessment:</b> None
S07	<b>Score of Technical Feasibility:</b> 3, <b>Risk Assessment:</b> Medium, <b>Risk Explanation:</b> 1) False Fall Detection event possible to occur as identification or variation of movement by Kinect camera is not accurate; 2) Technical difficulties may occur when developing the phone line based dispatching technology, <b>Risk Mitigation:</b> 1) When a Fall is detected do not notify the caregivers immediately. Ask the elderly first if he/she is ok otherwise notify; 2) Use of existing cloud based dispatching services (e.g., Nexmo.com)
S08	<b>Score of Technical Feasibility:</b> 3, <b>Risk Assessment:</b> Medium, <b>Risk Explanation:</b> Identification of (very small) objects by a Kinect camera is not accurate or not possible. <b>Risk Mitigation:</b> A list will be provided with the objects that can be detected and identified by a Kinect camera. For very small objects that cannot be identified by the Kinect camera another technical solution will be adopted (e.g., ibeacons).
S09	<b>Score of Technical Feasibility:</b> 5, <b>Risk Assessment:</b> None
S10	<b>Score of Technical Feasibility:</b> 4, <b>Risk Assessment:</b> Low, <b>Risk Explanation:</b> Minor technical difficulties may occur when developing the phone line based dispatching technology, <b>Risk Mitigation:</b> Use of existing cloud based dispatching services (e.g., Nexmo.com)
S11	<b>Score of Technical Feasibility:</b> 4, <b>Risk Assessment:</b> Low, <b>Risk Explanation:</b> 1) Minor technical difficulties may occur when integrating certain commercial window sensors; 2) If power is lost, sensor's connection to the workstation will be lost, <b>Risk Mitigation:</b> 1) Use of another type/brand of commercial window sensor; 2) If connection with the sensor is lost, the elderly/caregiver/administrator will be notified.
S12	<b>Score of Technical Feasibility:</b> 5, <b>Risk Assessment:</b> None
S13	<b>Score of Technical Feasibility:</b> 5, <b>Risk Assessment:</b> None
S14	<b>Score of Technical Feasibility:</b> 5, <b>Risk Assessment:</b> None
S15	<b>Score of Technical Feasibility:</b> 5, <b>Risk Assessment:</b> None
S16	<b>Score of Technical Feasibility:</b> 3, <b>Risk Assessment:</b> Medium, <b>Risk Explanation:</b> Identification of (very small) objects by Kinect camera is not accurate or not possible. <b>Risk Mitigation:</b> Restrict the identification to a set of objects that can be identified with acceptable accuracy by the Kinect camera; Coloured markers may be used for some of the objects. In case the objects that may be useful for the elderly to detect cannot be recognized by the Kinect camera, another technology may be adopted. For example, coloured markers may be used for some of the objects.
S17	<b>Score of Technical Feasibility:</b> 5, <b>Risk Assessment:</b> None
S18	<b>Score of Technical Feasibility:</b> 5, <b>Risk Assessment:</b> None
S19	<b>Score of Technical Feasibility:</b> 3, <b>Risk Assessment:</b> Medium, <b>Risk Explanation:</b> 1) In a real-life environments the emotion recognition and/or behaviour analysis, may be inaccurate (in this case the service will not be triggered); 2) Sensors are not able to cover the entire space of the residence, therefore there may be significant gaps in the recognized behaviours, <b>Risk Mitigation:</b> 1) Build a personal emotion profile which will be used as reference for the emotion measurements (which will be carried out for a certain time period instead of instantaneous); This will improve the reliability of the recognized emotion; 2) Revise behaviour analysis module algorithms based on recognition results using real data in order to improve the recognition rates and models; 3) Introduce low cost sensors (e.g., PIR, pressure) to help cover the gaps;
S20	<b>Score of Technical Feasibility:</b> 4, <b>Risk Assessment:</b> Low; <b>Risk Explanation:</b> The physical exercises in the videos might not be appropriate for the elderly (health status and disabilities). <b>Risk Mitigation:</b> Film videos specifically designed by experts (e.g., physiotherapists) will be provided.

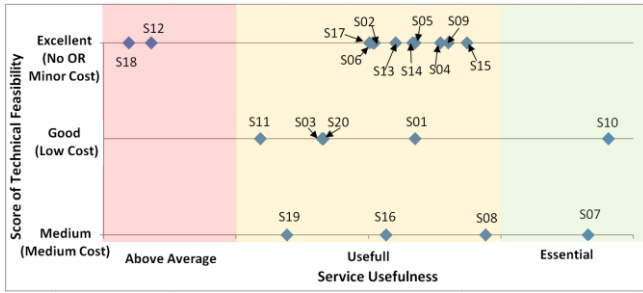


Fig. 3 ICT Services Assessment: Usefulness Vs Technical Perspective ("Cost" of Development)

## V. CONCLUSIONS

The conclusive results of this study have revealed that both elderly users and caregivers consider a particular set of services as very important to be supported by an ICT-based system for Ageing Well. More specifically, the results show that both the elderly and caregiver users consider services that improve safety and quality in elderly Health Care (e.g., Fall Detection and Alerting, Call for Help and Alerting, Dangerous Object Adviser, Medication service and Reminders, etc.) as essential or very useful as they provide the elderly with assurance that they are being attended, protected and cared for, therefore, motivated to continue their active life at home. Also the care stress by the formal and informal caregivers is reduced.

Services that stimulates socialization and communication of the elderly with their family/friends/neighbours/etc., (Appointment Reminders, Contact Assistance, Event/Group Activities, Messaging, etc.) are also considered as very useful as they increase the elderly social interaction, preventing loneliness and isolation, contributing thus positively to their wellbeing, improving also their autonomy, independence and confidence. Equally useful are also considered the services that stimulates daily activities of the elderly as well as healthy and active life (Shopping assistance, Agenda, service, Physical Activity service, Periodic Advice, Notifications, etc.), as they enable them to live actively and independently for longer in their home environment, thus delaying admission in hospitals and nursing homes. Also care stress, demand of care resources and the burden of care by the formal and informal caregivers, is reduced.

Finally, some other services such as Motivation for Physical Activity, Windows Monitoring, Go to bed reminder, and Meal Preparation assistance, are classified as "good to have" for increasing the overall well-being, improving the healthy and independent living of the elderly and assist

them to remain active for longer at home.

The results extracted from our study and provided in this paper (summarized also in Fig. 3) can be considered by other projects working in the area of Ageing Well and assist the consortium to gain an insight about i) which ICT services can provide the greater benefit to the elderlies' and their caregivers' QoL, and thus reduce time and resources needed to be allocated for identifying, from scratch, the services that will be supported by their system, and ii) the technical perspective of the ICT services and prioritize their development, as well as, facilitate better allocation of their resources, to minimize any risks that could result in failure to implement these services in the framework of their project.

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## CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

## REFERENCES

- [1] The 2015 Ageing Report: Economic and budgetary projections for the 28 EU Member States (2013-2060) at [http://ec.europa.eu/economy\\_finance/publications/european\\_economy/2015/pdf/ee3\\_en.pdf](http://ec.europa.eu/economy_finance/publications/european_economy/2015/pdf/ee3_en.pdf).
- [2] World Economic Forum (2012), Global Population Ageing: Peril or Promise?, Global Agenda Council on Ageing Society at [http://www3.weforum.org/docs/WEF\\_GAC\\_GlobalPopulationAgeing\\_Report\\_2012.pdf](http://www3.weforum.org/docs/WEF_GAC_GlobalPopulationAgeing_Report_2012.pdf)
- [3] Miraculous Life for Elderly Independent Living at <http://www.miraculous-life.eu/>
- [4] Broek G. V. D., Cavallo F, and Wehrmann C. ( 2010) AALLANCE Ambient Assisted Living Roadmap, Vol. 6, IOS Press.
- [5] Katrin G., Michael C. (2010) ICT enabled independent living for elderly, Institute for innovation and Technology, Germany, ISBN 978-3-89750-160-7

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