PROJECT
Coach assistant via projected and tangible interface
GRANT AGREEMENT
Nr. 769830

D2.1. – First version of user requirement analysis

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LIST OF ACRONYMS

Acronym	Description
ADL	Activities of Daily Living
PD	Participatory Design

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1 EXECUTIVE SUMMARY

Task 2.2 – "Agile requirements elicitation through user involvement" is to define user requirements using the agile elicitation methodology through active and continuous involvement of the stakeholders' network. The Active stakeholders' network created during the Task 2.1 – "Stakeholders' network engagement and participatory design" will be the only official source of requirements, except from the requirements specified in this document that are an initial approach and constitute a reference guide for the development of different functions of the CAPTAIN ecosystem.

In order to identify the user requirements and usability issues, a series of steps were followed. As a starting point the consortium took into account the literature study of EU projects that elicited requirements through end-users' engagement. Adding to that, research papers describing the e-coaching concept were studied. The consortium's background experience was depicted in the creation of personas and users' scenarios. These play a bilateral role for the requirement elicitation process: first, to build empathy among the consortium and the end-users' needs and desires and, secondly, they are useful for the active stakeholders' network to figure out what CAPTAIN is and start giving meaningful feedback.

CAPTAIN has proposed adoption of a participatory design process within the Active and Healthy Aging context where end-users participate actively in the project's lifecycle through the stakeholders' network. This approach aims to harness the expertise at all levels of the stakeholder ecosystem in order to ultimately deliver an effective and user driven new ICT approach for people in need of guidance and care due to age-related conditions. In fact, the development team will apply agile requirements elicitation and development methodologies through participatory design throughout the lifecycle of the project, from design to development and test.

The first version of the analysis has identified 67 functional and 24 non-functional user requirements. In line with an agile methodology approach, the first set of requirements will be updated after the first meetings with the end users and it will be constantly subject to further reviews throughout the project duration.

2 INTRODUCTION

2.1 PURPOSE AND STRUCTURE OF THE DOCUMENT

The scope of this document is to identify and present the first version of the user requirements. The systematic approach that was used in the identification process is also described. Furthermore, a section of this deliverable is dedicated to the creation of the first "backlog" with prioritized user requirements.

To this end, this document is structured in eight sections, as follows:

- Section 1 provides the executive summary of the document;
- Section 2 provides a brief introduction regarding the coaching concept which encapsulates one of the main objectives of the CAPTAIN project and the introduction to agile elicitation methodology that will be used across the CAPTAIN project for requirements elicitation;
- Section 3 is dedicated to the presentation of the methodology for identification and analysis of the user requirements including the description of literature study analysis, the definition and

consolidation of personas and user scenarios as well as the procedure followed for requirements prioritization;

- Section 4 provides the first set of identified user requirements and it categorises them into functional and non-functional ones;provides the prioritized requirements and it defines the first backlog; finally
- Section 5 discusses the findings and the next actions related to this deliverable.

ANNEX 1 and ANNEX 2 provide a description of the EU projects and the research papers that were studied for this deliverable. ANNEX 3, ANNEX 4 and ANNEX 5 include the older adults' and caregivers' feedback that has been used in the process of refinement of personas and user scenarios, gathered, respectively, by AUTH, INTRAS and APSS.

2.2 THE CONCEPT OF "COACHING" IN THE DOMAIN OF ACTIVE AND HEALTHY AGING

One of the main objectives of CAPTAIN is to create a contextualized and personalized e-coaching assistant for people as they age. Recent years have seen an ongoing movement promoting development of coaching practises in various domains as well as their digitalization and automation. These include promoting physical activity (Klein, Manzoor, Middelweerd, Mollee, & Te Velde, 2015) (Petsani, Kostantinidis, & Bamidis, 2018), balance and nutrition (Boh et al., 2016), depression (van de Ven et al., 2012) and insomnia (Beun et al., 2016), to name but a few. Some key points and findings typical of such an e-coaching system may include:

- Capability to collect information from the user, in context and over time, to learn about personal thoughts, preferences, behavioural patterns and the changes that may occur. The system must observe, reason about and learn from the user. This can be done by unobtrusive monitoring of user's behaviour, emotion and movement as well as by environmental monitoring.
- Possibility to provide advice and guidance about age-related issues that can affect a person's ability to remain active and independent including physical activity, risk avoidance, social participation, diet, lifestyle and leisure activities, preventive measures and overall wellbeing.
- Proactive behaviour necessary to initiate interactions with the aim of stimulating actions or reflections by the user, stimulate and motivate them to follow the system's proposals and not to adopt them without criticism.
- Careful design to avoiding consuming too much of the user's time (avoiding "attention grabbing"). The coaching system should provide feedback and advice and take back user's opinion and preferences without intervening in his/her everyday life routine. This can be done by radically new user interface that will not require special effort to use and will not require any special experience.

The overall goal of CAPTAIN's e-coaching system is to preserve physical, cognitive, mental and social well-being for people as they age, assisting them to maintain their autonomy and daily habits for as long as possible. Therefore, the e-coaching system has been envisaged in a scalable fashion based on several modules that can be adopted, when required.

2.3 AGILE REQUIREMENT ELICITATION

Participatory Design (PD) is believed to be one of the most important requirements of good design as it implies active involvement of the end users in the design process. PD is focused on processes that keep all stakeholders actively involved, as they become participants and co-designers in the design process

and not just passive consultants. Participation is the key change that differentiates PD from other traditional methodologies such as user-centred design and user-driven innovation, although the term participation differs from project to project and study to study (Halskov & Hansen, 2015).

Most of the studies and EU funded projects focusing on PD are relying on face-to-face meetings with end-users, clinical and technical professionals who were asked to define early in the project the use case scenarios. This is often done though focus groups, surveys, interviews and literature research or web-based surveys by technical professionals (developers, engineers, etc.) to help focus the scope of the system and accumulate the information and model it. However, traditional project teams run into trouble when they try to define all the requirements upfront, often the result of a misguided idea that developers will actually read and follow what the requirements document contains. For a project such as CAPTAIN, which investigates new intelligent ICT approaches, aiming at a proof of concept, investment in detailed documentation early in the project, which will inevitably change, should be avoided.

CAPTAIN goes beyond the usual PD and requirements elicitation techniques that are currently used in many EU funded projects by using agile development. Agile development is an approach under which requirements and solutions evolve throughout the lifecycle process of the development through the collaboration and participation of cross-functional teams and end-users. The agile development approach was adopted in order to increase development performance in terms of continuous, efficient and effective adaptation in user requirements changes (G. Lee & Xia, 2010). Some of the main principles of agile development include frequent delivery of working modules to maintain end-user satisfaction, the acceptance and welcoming of requirement changes even in late development, face-to-face conversation between end-users and development team, or among development team members is the best practice.

During CAPTAIN, a stakeholders' community will be created among all living labs and pilot partners who will actively engage users (e.g. older adults, formal and informal caregivers) in the agile development procedure. The CAPTAIN community requires tight bonds to be created among all the stakeholders and the active participation of the stakeholders' network throughout the project. Frequent interaction with end-users will be promoted to generate high trust.

To do so, a hybrid approach leveraging on concept from Design Thinking, Lean Startup approach and SCRUM agile framework will be followed by the project. Given that CAPTAIN introduces, develops and validates radically new ICT based concepts, Design Thinking (supported mainly by the pilot partners) will allow us to discern unmet needs and create value from these insights. Lean approach (served by both pilot and technical partners) will enable delivering a partially functional prototype frequently enough to the stakeholders in order to collect feedback, validate our assumptions and readjust. The use of SCRUM will instead help organize work across technical partners to collaborate towards delivering high value. This hybrid approach will facilitate CAPTAIN to solve effectively and with high flexibility complex project developments required to achieve its goals, as detailed below.

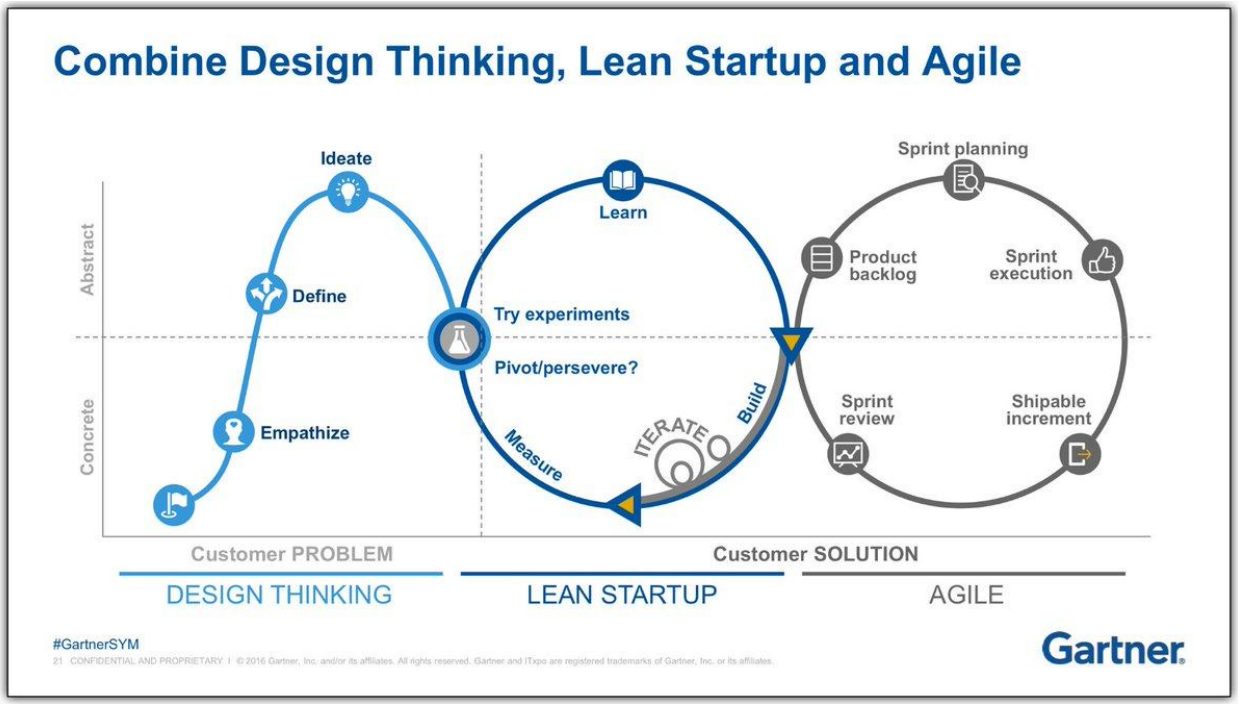


Figure 1: the combination of design Thinking, Lean Startup and Agile methodology. Source: [Gartner]

SCRUM is an iterative and incremental framework for managing product development. With "iterative and incremental" we mean a transparent cyclic process of planning, implementation, testing and evaluation as illustrated in Figure 1.

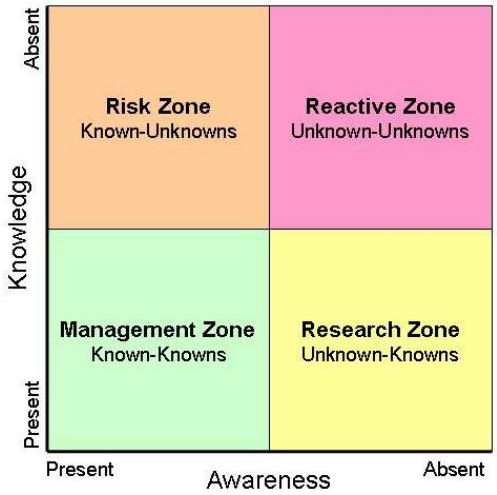


Figure 2: Map of unpredictable zones for SRUM methodology

Some of the main challenges a team has to face according to SCRUM methodology is the "dual recognition", that is, on the one hand, the end-users will have to change their minds about what they want or need and, on the other hand, there will be challenges inevitably unpredictable to deal with. This means that the problem cannot be fully understood (the so-called "unknow unknowns") and the solution provided cannot be fully defined up front. On the other hand, it is essential to try to move from the "unknown unknowns" to "known unknowns" and finally to "known knowns", in order to be able to better manage the project's final deliverable and initial set of common sense requirements. Such an evolution, in fact, would save technical teams precious time and would contribute to minimizing any risk of delay.

By implementing such a process, the current document describes the initial planning of user requirements that will be adjusted, refined and reprioritized throughout the lifecycle of the project. As a result, the backlog of requirements will be updated during the project whole lifecycle after every interaction with the stakeholders, to capture the most valuable requirements (both from the end-users

and the researchers' perspective) and to maximize the acceptance levels beyond the life cycle of the project. For this reason, this document constitutes a living and continuously evolving document, aiming at distributing a precocious set of user requirements, to enable early enough the active stakeholders' network figure out what CAPTAIN is and start giving meaningful feedback

3 METHODOLOGY FOR THE IDENTIFICATION AND ANALYSIS OF FIRST VERSION OF USER REQUIREMENTS

3.1 USER REQUIREMENTS IDENTIFICATION AND ANALYSIS

An important task for CAPTAIN is to identify, at an early stage, basic user needs and requirements. These requirements will become initial input for the participatory design and agile requirements elicitation process and will be later re-evaluated and changed based on end-user input and consultation. More specifically, the initial step will be to capture existing and validated knowledge (while giving it back to the research community through this public deliverable) during the first version of user requirement elicitation, primarily through an open literature study. This information is considered as the starting point and it comes from discovering older adult needs and the deployment of use cases in previous, successful ICT projects. It should be noted that, while defining user needs, the exploitation of CAPTAIN's consortium expertise, built upon interaction with stakeholders and elderly care organizations, was crucial. Such an interaction has allowed technical partners to define key technical constraints that need to be considered.

The literature study has aimed at finding European ICT projects that have developed technologies to improve everyday life, autonomy, social participation, physical and cognitive state of older adults. The results of this literature study have provided the theoretical background and the appropriate feedback to reflect end-users' daily life habits and patterns, their skills, their expectations and their ideas onto the first version of user requirements. The expertise of the consortium has been then translated into the creation of personas and user scenarios.

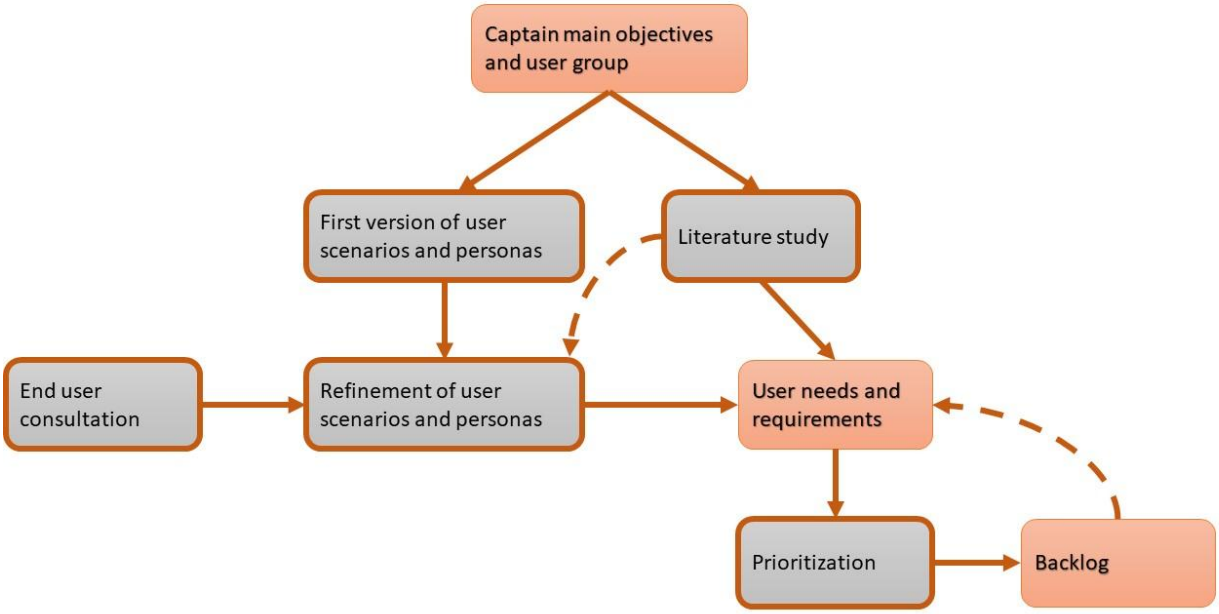


Figure 3: Methodology for CAPTAIN requirements specification and analysis

3.1.1 CAPTAIN User groups and objectives

CAPTAIN is not addressing people in need of specific treatment or care (e.g. due to a specific disease), instead it addresses older adult population in need of guidance and care due to general age-related conditions. CAPTAIN focuses on increasing motivation and positive interest of the end users. The five main user groups where described as:

1. Older adults with memory impairments and MCI (Mild Cognitive Impairments).
2. Older adults with motion impairments.
3. Older adults in need of maintaining physical and cognitive independence.
4. Older adults in need of socialization.
5. Caregivers and organizations dealing with ageing people.

The main objectives, that the first version of user requirements targets, are:

- O#1: To dynamically monitor older adult's behavioral change through unobtrusive behavioral data sensing
- O#2: To provide personalized guidance CAPTAIN through a dedicated motivation engine designed to engage users in healthy nutritional and exercise habits, cognitive activities, to maintain and improve cognitive fitness, as well as to promote and/or maintain social interactions and leisure activities among older adults.
- O#3: To develop a virtual coach based on Artificial Intelligence (AI) to provide personalized and contextualized guidance.
- O#4: To develop new approaches to increase engagement levels with physical and cognitive training. To do so CAPTAIN will deliver physical and cognitive training through serious games which will be capable to adapt to evolving skills to avoid the user getting bored or, conversely, feel frustrated (causing withdraw). CAPTAIN will also explore social leverages of gamification, for instance by proposing gaming campaigns whose rewards can be donated to local communities (i.e. senior clubs, nursing homes).

3.1.2 Literature study

Previous projects and research studies form recent literature were rigorously studied to obtain knowledge and use the gathered information as a starting point for further analysis. The main concern was to identify older adults needs and opinions according to social activities, social participation and barriers, personal fears about everyday life and activities. Also, at this phase, one of the main objectives was to define how an ICT solution can support physical and cognitive training and provide personalized guidance and motivation. The study aiming at identifying the correlation between technology, ICT services and achieving high Quality of Life (QoL) in older adult population regarding independent living and self-management.

The study of the literature provided a set of requirements that are related to CAPTAIN objectives described in 3.1.1 as well as input for the creation of user scenarios.

3.1.2.1 EU projects

A survey of relevant projects in the area of Information and Communications Technology (ICT) for Ageing Well, including diverse and innovative solutions in all aspects of life for elderly people, was conducted. Main constraint for the literature study was that every study considered must have involved at least one senior or stakeholder in the requirement elicitation process. Projects that delivered user requirements based only on the consortium's knowledge and experience were excluded. These constraints were set based on the belief that end user participation can create a better insight on their opinion and needs. As the end users will be actively engaged throughout the CAPTAIN project, first version of user requirements has focused only on existing knowledge that other European projects had mined beforehand. Moreover, the studies that have been analysed, had either public deliverables describing the user requirement analysis process followed or were part of previous or ongoing relevant projects that CAPTAIN's partners are involved. The projects studied had begun since 2008 or later and had received FP7, Horizon 2020 or AAL call grants, while study of scientific publications was extended to even earlier timeframe .

The projects discussed here, shown in Table 1 have employed ICT in an attempt to address aspects important for improving the quality of life of older adults like increase of autonomy, establish long term social relationships that will allow social interactions and participation, and assist the elders in their everyday needs, physical and cognitive care.

Table 1 EU projects

Project
i-PROGNOSIS, http://www.i-prognosis.eu/
I-DONT-FALL, http://www.idontfall.eu/
FrailSafe, http://frailsafe-project.eu/
GrowMeUp, http://www.growmeup.eu/
MoveCare, http://www.movecare-project.eu/

HERMES, http://www.fp7-hermes.eu
HEARTMAN, http://heartman-project.eu
ACANTO, http://www.ict-acanto.eu/
Active@Home, http://www.active-at-home.com/
TERESA, https://teresaproject.eu
INDEPENDENT, http://independent-project.eu/
Care well, http://carewell-project.eu
iStoppFalls, http://www.istoppfalls.eu
ALFRED, https://alfred.eu/
Miraculous Life, http://www.miraculous-life.eu
Guide, http://www.guide-project.eu
CaMeLi, http://www.cameli.eu/site/
iToilet, http://www.aat.tuwien.ac.at/itoilet/
RADIO, http://radio-project.eu/
MyMate, http://www.mymateproject.eu/
APOLLO
DECI, http://deci-europe.eu/deciproject/
inCASA, http://www.incasa-project.eu/news.php
PersonAAL, http://www.personaal-project.eu/

The recommendation drawn from these projects' study were the content of the requirements from each project, that were adapted to the CAPTAIN project. Each of these projects have defined a set of requirements based on end-user engagement. The work was proceeded with the identification of the requirements from every project and research papers that had potential value and relation with the CAPTAIN project, as follows. Some requirements excluded as non-relevant with CAPTAIN; for example, those describing requirements about a robot assistant for older adults. On the other hand, even such not so relevant systems include use cases about user guidance that could be implemented by CAPTAIN too. Thus, this information was included.

The results of the requirements extracted from the revised EU projects are listed below.

Table 2 Requirements extracted from EU projects

Title	Description
Self-report ADL	The user's activities of daily living should be monitored through questionnaires that would be delivered daily from the system.
Monitoring in ADL	The system must have the ability to monitor user body posture and gestures during ADL and detect changes of the user's capacity to perform activities of daily living. This can include the measurement of several body angles or body parts velocity.
Emergency recognition and handling	The system must continuously monitor the user in order to detect fall and general emergency situations and inform family or caregiver to provide assistance
Night wandering	Tracking wandering, night wandering syndrome or any other abnormal displacement at night
Risk of falls	The system must detect risk of falls by monitoring user's indoor movements in order to identify gaps and anomalies (change in walking speed, anomalies in gait patterns)
Monitor Cognitive function I	The system must achieve cognitive assessment and monitoring through the execution of (digital) neuropsychological tests
Monitor Cognitive function II	The system must achieve cognitive assessment and monitoring through cognitive state-assessing game
Monitoring in physical activities	The system must monitor user's body posture, gestures, angles and velocity during exercise
Monitoring Sleep	The system must monitor abnormal behaviors during sleeping time. (e.g. staying too long in bed or getting up too many times during the night)
Facial Emotional Recognition	The system should be able to analyze the facial expressions of the users in real-time and provide information about the user's emotional state
Speech Emotional Recognition	Implement techniques for recognizing the emotions contained in speech
Behavioral monitoring	The system should be able to detect a lack of activity for long period of time considering the physical capacity of the user
Import health-related data	Allow older adults to store health-related measurements manually and make notes about each measurement
Social Physical Exercise	Game solution allowing users to play/exercise with others
Social Cognitive Exercise	The system should provide a way for different users to play cognitive games with their friends on-line

Facilitate communication	The system must facilitate and enable user to communicate with friends, family, caregivers etc.
Making appointments	Support older adults in making appointments with caregivers, doctors etc. remind older adult when it's time to make an appointment for a regular check-up with a caregiver
Virtual Community Platform	Allow older adults to share self-monitoring data and/or exchange information
Display user's activity plan	Display activity plans of users to specific others depending on user's desire and privacy profile
Promote social interaction	Provides a means to communicate and generate new friendships based on location and/or common interests
Agenda-system proposing local activities	System should provide information about events taking place in the area and therefore propose activities
Common calendar reminder functionality	Reminders for weekly scheduled activities (e.g. hairdresser appointment), monthly payments, annual for birthdays or anniversaries
Medication reminder	The system must provide reminders for daily medication in order to increase adherence to treatment, occasional reminders related to individual needs such remind older adult when he/she should perform a specific health management task (e.g. request new medication prescriptions, updating medical file)
Therapy monitoring	The user should be able to see whether he/she has already taken his/her pills in order to avoid overdose
Food and meals	Information about creating a general shopping list based on the menu of the week and nutrition plans
Exiting house reminder	The system must remind the user to take his/her personal belongings with him/her when leaving the house
Media use I	The system must assist the user to watch movies
Media use II	The system must assist user to search for events of her/his interest
Personal data visualization	Provide feedback through visualization of user data collected to give easily comprehensible personalized feedback
Finding objects I	The system must keep the storage place of some objects in a database (e.g. significant papers)

Finding objects II	The system must help the user locate personal items (e.g. keys) based on their request
Verbal Interface I	The system must be controlled by spoken commands
Verbal Interface II	The system must use voice guidance, the information must be provided to the user by speech technology
Verbal Interface III	The system must listen to the user only by his/her command (e.g. by pushing a button)
Emotional UI	The system must provide an interface based on information about older adult's emotional state and speech characteristics provided by user monitoring and produce relevant outcomes based on the emotional recognition
Multimodal Interface	The oral given commands should be accompanied by visual clues and text information
Target spontaneous question	Initiate questions, in the domains of user's interest such as cinema, exhibitions, cooking etc. to keep the user engaged and motivate social interaction
Physical training I	The physical exercise protocol must involve physical activity targeting full body exercise
Physical Training II	Physical training programs at home are very convenient and highly proposed for older adults so the system must provide an in-home solution for physical exercise
Physical Training III	Physical training program must include two to three days per week of exercises, no more than 30 minutes each
Physical Training IV	The system must provide a report on physical activity, showing training performance
Physical Training V	There should be the possibility to exercise with music
Recommendation for fitness activities	Recommend fitness-appropriate activities for users
Body and brain exercise	The system must engage the user in games that require the combination of mental and physical exercise
Coaching in physical activities I	Help older adults predict when they can and can't do an activity (e.g. taking into account recent/future activities, good/bad days etc. based on user monitoring), help user design a physical activity and exercise plan
Coaching in physical activities	Advice on suitable intensity, duration and suitable time for physical exercise based on personalized needs e.g. Shortening durations, shortening distances, Using

II	lighter material, Lowering intensity, Using assistive tools
Medication advice	Support older adult to organize medication to facilitate correct intake Provide strategies to create routines to facilitate correct intake
Cognitive exercise I	The system must engage the older adult in games that are entertaining while enhancing cognitive functions and memory training
Cognitive exercise II	The system must support/enable the older adult to look at old photos in order to stimulate memories
Well-being self-management	The system must educate older adults about bodily signals they should be aware of that might indicate a physical problem
Health education	Prevent older adults from becoming hyper-aware/anxious of their condition due to frequent self-monitoring,
Coaching Nutritional Habits	Provide nutritional advices and suggestions for recipes based on personalized needs, avoid malnutrition
Social interaction reminder	Advice on staying in touch (taking initiative) with friends, support older adults in maintaining (or improving) their close relationships with family and friends by proposing and reminding activities involving the older adult's relatives and friends
Recommendation for activities	Make recommendations for activities based on stored information about previously enjoyed activities and stated interests
Advice on user posture	Recommend that user changes posture during an activity, feedback to learn the right movements and posture
Monitor acceptance or reject history	Remember users' previous history of rejects and accepts in system's proposals in order to learn preferences
Measure Bio-signals	Support older adults to pay attention (measure frequently) to bio-signals (e.g. measuring body weight, blood pressure)
Accept or reject recommendations	Allow users to accept or reject recommendations
User technical support	The user must be able to request and receive help and technical support
Possibility of oblivion	Users should be able to withdraw themselves and their data at any time from the system for any reason
Possibility to specify data to reveal	Users should be able to specify how much information they reveal and to whom

User's data protection	Users should be protected from revealing too much information about themselves
User's data collection	Personal data should be easily accessible by the end-user, as well as possibilities for personal control by the end-user
Privacy Regulations	To ensure compliancy to EU regulations (e.g. GDPR) as well as to national legal frameworks
Lag in the interface	All interaction should get a feedback within 500 ms at most, to avoid the user experiencing delay
Software updates	Updates and bug fixes should be performed on the server without distributing new versions of the software to users
Real time exchange of information	Data base and exchange of information should be updated in real time
No Cables	Avoid the use of cables not to cause accidents
Improved access to agendas and reminders	Any development must imply an advantage in comparison with their agendas, calendars etc to be usable and accepted by older people. The system shall make it possible to provide this kind of free-form information and not restrict the user to forms and fixed inputs.
Module configuration	The system has to be fully flexible and adjustable to the needs of each person and include only specific modules, modules can be turned on and off at any time
Installation Process	The system must have anything pre-installed so that the user do not have to set up anything
Not invasive interface	Interface must not irritate, distract or block view
Notifications off	The user needs to have the possibility to completely turn off notifications when he/she wants
System's voice	The system must speak very slowly and clearly
Interface Layout	Only necessary items should be provided per working page. Do not include functions that are not necessary (e.g. system configuration item).
Icons/Glyphs	Standard/Self- explanatory icons Intuitive visual items (icon and glyphs)
Text	Easy-to-read typography, concise text. Dark text on a solid light background, to allow all users to read easily. Large text size
Colors	Neutral Colors, use of red, yellow, and green as status indicators; globally consistent and culturally independent, intense color contrasts between the

	background and icons/text, the background should not be too dark or too bright because these colors make participants sight get tired easily
User Interface Simplicity	The user must be able to perform a task taking the minimum steps in the UI, not requiring searching a module by himself, the visual design/graphics has to be reduced to the essential adjusting to elderly people's abilities (not too much stimuli)
User Interface Usability	The user interface must not require fine movements (size of the buttons, buttons not too close one from another)
Automatic self-check the most important features	Automatic routines for detection of anomalies that may compromise functioning of the system
System Responsiveness	The system must present an appropriate indicator when an action takes time to complete (e.g. loading bar)
Multilingual platform	There must be versions of the platform in many languages
Confirmation	The system should ask for confirmation, whenever applicable, before performing an action (e.g. in emergency situation detection, the system should first ask the user if he/she needs help before informing the relatives)

3.1.2.2 Bibliometric Study

One issue not extensively studied by the selected EU projects is the e-coaching aspect that, conversely, is one of the main foci of CAPTAIN. To bridge that gap, research papers on e-coaching systems were instead analysed. Virtual coaching-related evidence was collected systematically by searching, mainly, in two search engines: IEEE and PubMed with some additional works identified within the ACM digital Library. The papers studied are presented in the following table.

Table 3 Research papers studied

Reference
The COACH prompting system to assist older adults with dementia through handwashing: An efficacy study. (Mihailidis, Boger, Craig, & Hoey, 2008)
MOPET: A context-aware and user-adaptive wearable system for fitness training. (Buttussi & Chittaro, 2008)
Context awareness in a handheld exercise agent. (Bickmore, Mauer, & Brown, 2009)
Lifelogging memory appliance for people with episodic memory impairment. (M. L. Lee & Dey, 2008)
Persuasive Technology for Human Well-Being: Setting the Scene. (IJsselsteijn, de Kort, Midden, Eggen, &

van den Hoven, 2006)
Flowie: A persuasive virtual coach to motivate elderly individuals to walk. (Albaina, Visser, van der Mast, & Vastenburg, 2009)
FORECAST – A cloud-based personalized intelligent virtual coaching platform for the well-being of cancer patients. (Kyriazakos, Valentini, Cesario, & Zachariae, 2018)
Towards a virtual coach for manual wheelchair users. (French, Tyamagundlu, Siewiorek, Smailagic, & Ding, 2008)
Effect of a virtual pain coach on pain management discussions: A pilot study. (McDonald, Walsh, Vergara, & Gifford, 2013)
Virtual training and coaching of health behaviour: Example from mindfulness meditation training. (Hudlicka, 2013)
A virtual coach for upper-extremity myoelectric prosthetic rehabilitation. (Woodward et al., 2017)
The virtual personal health coach: Technology and data analytics join forces to disrupt preventive health. (Hoof, 2017)
Feasibility of a virtual exercise coach to promote walking in community-dwelling persons with Parkinson disease. (Ellis et al., 2013)
E-coaching systems: What they are, and what they aren't. (Kamphorst, 2017)
Encouraging Physical Activity via a Personalized Mobile System. (Klein et al., 2015)
Improving adherence in automated e-coaching: A case from insomnia therapy. (Beun et al., 2016)

According to IEEE, there are 94 publications related to the topic "virtual coach" by searching for this keyword within the timeframe 1993-2017. While the first 50% of the papers were published across a 19 year timespan, the remainder were published from 2012 on, that is over only 5 years. However, not all the papers were addressing health-related issues. The "virtual coach health" tag was found on 16 papers, published in 2008-2017 time frame. Most of them (12 out of 16) were published from 2012 on. Due to the recent emerging of the technology, no temporal filters were applied to the systematic review.

Most of the reference studies have a publication year ≥ 2012 (9 out of 12). The rest were not published long before 2012 (2008-2010). Concerning the search engine, 6 out of 12 papers were found in PubMed, 4 in IEEE, 1 in ACM Digital Library and 1 in a project official website. The first search tag used in PubMed and IEEE was "virtual coach", which mostly provided articles referencing virtual coaches focused on physical exercise (8 out of 12). The following search tags were "virtual-coach self-care" and "virtual health care", which provided a more varied types of virtual coach functionalities, from memory impairment, to health behaviour and backsliding again into physical activity. When looking for information about virtual coaches' capacities to adjust to users, the search tag was "virtual coach

personalized". The virtual coach that copes with behaviour changing was detected using the "virtual coach health behavior change management" tag.

In broad terms, the results were categorized more generally, physical activity promotion is the main extended functionality of virtual coaches -working on exercise behavior (Buttussi & Chittaro, 2008; IJsselsteijn et al., 2006; Klein et al., 2015), walking stimulation (Albaina et al., 2009; Bickmore et al., 2009; Ellis et al., 2013) and prosthetic rehabilitation (Woodward et al., 2017). The second main functionality is health behavior -healthy habits and behavior promotion and mindfulness meditation (Hudlicka, 2013), and feelings' management (Kyriazakos et al., 2018; McDonald et al., 2013) .The third focus of functionality are the Activities of Daily Living (ADL) -assistance in hand-washing (Mihailidis et al., 2008) and locomotion advising for manual wheelchair users (French et al., 2008). By last, the less frequent topics are related to memory -memory recollection in patients with EMI (M. L. Lee & Dey, 2008) and to adherence improvement -applied to insomnia therapy (Beun et al., 2016).

The benefit of the Bibliometric study was to identify specific guidelines for the definition of the requirements regarding the coaching domain of the system. The requirements identified from the bibliometric study that have an added value for the CAPTAIN system objectives are presented below:

Table 4 Requirements extracted from bibliometric study

Title	**Description**
Monitoring in ADL	The system monitors the user when performing an ADL and detect if some prompts are not performed correctly
Coaching in physical activities	The system must provide audio and visual feedback on specific metrics regarding the correct completion of the exercise task but not in an aggressive way
Physical exercise adaptability	The system must develop an exercise plan based on user's profile (e.g. height, weight, age, physical condition)
Monitoring in physical exercise	The system must monitor user's physiological parameters (e.g., heart rate and temperature) during physical activities
Safety on physical activities	The system must provide safety advice on user posture and movement during physical exercise
Capture memories	The system must help the user recall and recollect more of the details of his/her experiences by looking at old photos
Physical exercise feedback	The system must provide feedback about the user's progress in time
Coaching sleeping problems	The system must support older adults to overcome sleeping problems (e.g. waking up, going to sleep, quality of sleep, and wandering)
Medication calendar	The system provide calendar with the timeframe in which the activity is supposed to be done and notifications depending on the urgency of staying within the timeframe
Educate about	The system could assist older adults to practice talking with their practitioner in

communicating disease symptoms	order to communicate their problem better
User input	The system must implement text-based, natural language dialogue (e.g. free form or multiple choice)
Activity planning	It is important that the system makes a schedule, sets a task, and works toward the self-set goal for physical activities
Activity Monitoring	An activity monitor continuously tracks the activity level during a day

3.1.3 Personas and user scenarios

The term persona refers to a fictional user profile that aims to describe the end-users of a product in a representative way. The main objective when creating a persona is to form a reliable and realistic representation of key end-users or stakeholders, describing their characteristics, needs, expectations and even demographic data based on data about real users. It is used within the consortium in order to better understand and always keep in mind users' and stakeholders' desires, needs, expectations and fears. Instead of talking in an abstract way, the persona assists the designers and stakeholders to personalize their users and discuss by name and reason about a group based on characteristics. They can also help make the right questions and build empathy with the end-users. Empathy is the ability to feel and understand what others want and expect from within their frame of reference.

The process of building a persona requires deep understanding and research of the targeted users. The user research does not refer only to the demographics and ethnographic but basically find out who the users are and why they need the proposed system. After concentrating the results of the user research, the design team along with the stakeholders must brainstorm to organize the elements and information gathered into personas, each of one depicting a specific case scenario.

As described above, the user requirements proposed in this deliverable are the initial version and are going to be adjusted during the agile requirement elicitation process. Personas of CAPTAIN will have a dual contribution, both in consortium's understanding and empathy and in end-user comprehension of the system's objectives.

The first version of personas for the CAPTAIN system was created during face-to-face plenary project meeting in Nice on February 2018. There were presented five user stories created by AUTH that were based on the project's objectives and user groups, demographics and ethnographic details. The consortium discussed and brainstorm to collect and readjust the user profile. Also, discussion was held upon ideas that can offer some solutions to the problems, thoughts, fears and opinions of the personas previously created. The proposed solutions were gathered and consolidated by AUTH in order to create a structured version of Personas.

The final results were the following personas.

<u>Persona Carlo</u>

Name: Carlo
Age: 70
Profession: Retired
Living Situation: Live alone, widowed
Family status: has a daughter who lives nearby
Health status: has recently undergone a surgery for a hip fracture caused by a fall occurred three weeks earlier
Care needed: the physiotherapist has prescribed physical exercise for regaining functionality and strengthening weakened muscles

Emotions: Carlo feels insecure and has lost self-confidence, is afraid that might fall again, feels depressed because of some functional difficulties he encounters due to the surgery, loneliness because of his wife's death

Wants and needs: - He wants to stay in contact with his friends, he used to meet them 2-3 times a week in a local café but know he finds it difficult to do so

- Wants to communicate with his daughter but is afraid of burdening her

Persona Dimitris

Name: Dimitris
Age: 78
Profession: retired
Living Situation: Live alone, widowed
Family status: 1 son who lives in another country
Health status: generally healthy
Care needed: no special care needed, maintain physical and cognitive independence

Emotions: - feels lonely, especially after his wife died and son left

- feels depressed sometimes

Wants and needs: - wants to socialize and stay in contact with his friends to reduce loneliness

- wants to contact his son and see his grandson but he can't cope with technology

Persona Fabio

Name: Fabio
Age: 81
Profession: Retired lawyer
Living Situation: Live alone, widowed
Family status: 2 daughters
Health status: Mild Dementia
Care needed: medical treatment, frequent visits from daughters or occupational therapist

Emotions: - feels that sometimes he can't concentrate on what is going on around him and that scares him

- is afraid of getting lost

Wants and needs: - wants to be calm and doesn't like stress in his life

- wants to communicate with his daughters but doesn't want to burden them
- wants to be informed about news, social and political life

Persona Hannah

Name: Hannah
Age: 73
Profession: Retired teacher
Living Situation: Live alone
Family status: no children
Health status: high blood sugar and pressure levels
Care needed: check her diabetes and blood pressure regularly, take appropriate medication

Emotions: is worried about her health deterioration, gets upset when a measurement is abnormal

Wants and needs: - needs to check her health but she isn't used to and often forgets it

- Wants to communicate with her doctor more often to reduce anxiety
- Likes to hang out with friends

Persona Maria

Name: Maria
Age: 72
Profession: Works in a local shop (family business)
Living Situation: Live alone, divorced
Family status: 2 sons
Health status: Mild Cognitive Impairment
Care needed: memory strengthening, reminders, physical exercise and balanced diet

Emotions: feels sad and frustrated when she can't function properly in her everyday life, afraid of forgetting electrical devices open causing a fire

Wants and needs: - Wants to continue doing her everyday activities and household works, especially cooking which she loved so much. Sometimes she forgets to add some ingredients.

Persona Sofia

Name: Sofia
Age: 67
Profession: unemployed
Living Situation: Live alone, widowed
Family status: 1 daughter
Health status: generally healthy but has recently developed instability problems
Care needed: physical exercise, improving balance

Emotions: - start to feel insecure for in-home movements

- fear that she may fall and can't call for help

Wants and needs: - wants to gain confidence again

- doesn't want to stop doing her everyday household activities because of fall or injury
- she is very active in her home environment and likes keeping everything in order

The version of personas presented above has been circulated and shared with all project partners. The partners commented and suggested changes on the personas, both from a technical point of view and from user need and acceptance point of view. AUTH refined the user scenarios and personas integrating the consortium's experience and suggestion.

In order to gain insight on the personas and user stories created by the consortium, the refined version of the personas and user scenarios was circulated among the living lab partners along with a presentation. ThessAHALL from AUTH, INTRAS and APSS engaged stakeholders in focus groups in order to present the CAPTAIN solution for the personas created. ThessAHALL engaged 1 healthy older adult and 2 facilitators, INTRAS involve 1 older adult with MCI and 2 facilitators and APSS involved 2 formal caregivers. The notes of the consultation sessions are presented in ANNEX 3: End user consultation from auth, ANNEX 4: End user consultation from INTRas and ANNEX 5: End user consultation from APSS. Users' feedback was consolidated by AUTH and incorporated in the refined version of personas and user scenarios, as follows. The directions given were for each group leader to try to create empathy between the stakeholders and the personas presented. Another researcher was keeping notes of the discussion. The goal was dual, on one hand to gain feedback about the feasibility of the personas and how realistic their profile seems to the stakeholders and on the other hand to gain an initial insight on the acceptance and quality of user scenarios and collect valuable feedback.

As the project continuous, the empathy of the consortium and the stakeholders' community for personas and consequently end-users, will grow. So, the current version of personas is not considered final as it is susceptible to changes throughout the project. Following the personas, the use cases adopted in each persona are presented along with illustration for each use-case. These illustrations will help to communicate each case within the stakeholders' community during the requirement elicitation process.

The updated result was to create a robust character for the personas and provide use case scenarios for the CAPTAIN system based on the profile of each persona, as follows.

3.1.3.1 Persona Carlo

CAPTAIN solution

The coach encourages Carlo to take some physical exercise that is essential for his rehabilitation. When he is relaxed, coach suggest performing some exercise through the exergames.

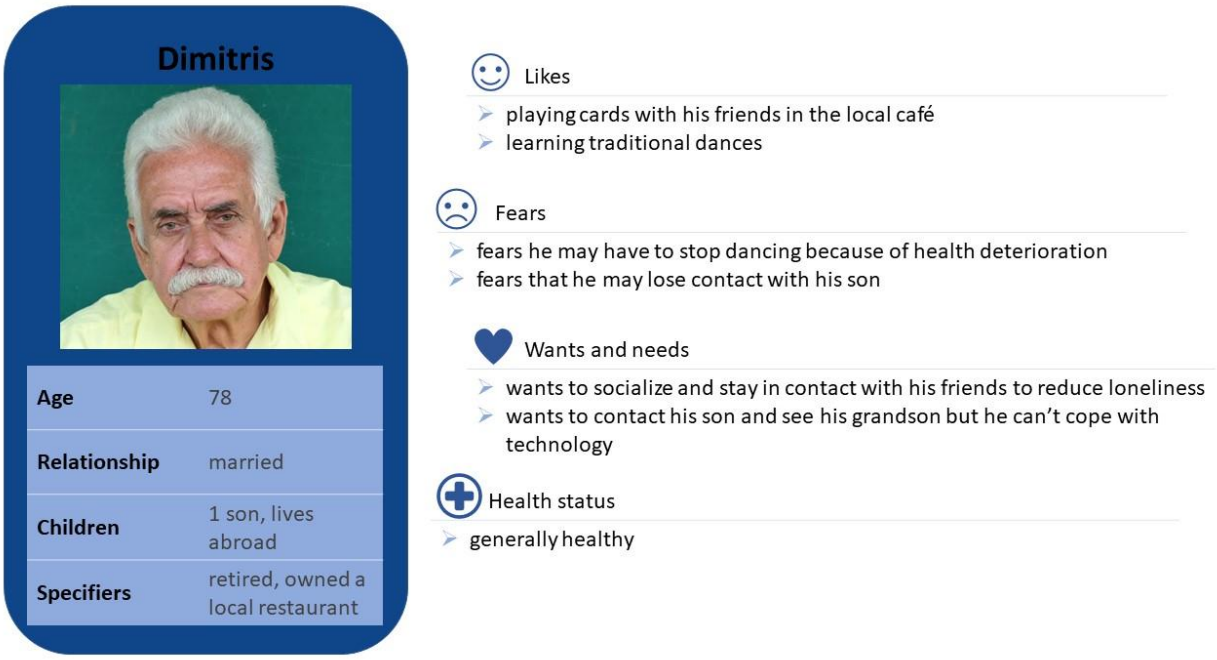
Carlo reads the gaming instructions (collecting virtual apples, virtual fishing, virtual hiking, etc.) projected on the wall and pays attention to the recommendations of the coach (oral and visual). The coach encourages Carlo to accomplish his gaming goals giving detailed instructions.

CAPTAIN provides Carlo the possibility of calling his friends so that they could be with him at home that afternoon since he could not go out and invite them to the "virtual tour" that Carlo needs to do for his recovery. Carlo decides to invite them for joining him tomorrow.

At the end of the session, the recovery exercise is a light walk on the spot while images from Google Street View appear on the walls all around him as if he was taking a virtual walk. Carlo asks his coach to take some photos of him with the background of the Google Street View projected on the wall which he enjoys sharing with his daughter. Carlo has previously approved the CAPTAIN to share pictures with his daughter.

Figure 4 Use case scenario depiction for persona Carlo

3.1.3.2 Persona Dimitris



CAPTAIN solution

CAPTAIN encourages Dimitris to take some physical exercise through exergames. The exergames are designed in cooperative or competitive activities and coach propose Dimitris to talk to their friends and challenge them to gain more points in the exergame (if his friends do not have access to the game Dimitris gains extra points only by making the call).

The coach also, informs Dimitris that his son is online and initiates a Skype call, projecting the video on the wall, helping Dimitris to talk to his family and see them regularly. Dimitris' son can add photos of himself and his family that his father may like to see. He could tell his father that he will be online that evening and they can talk then. The coach sets up a reminder on a calendar (projected on the wall opposite his favorite armchair where he spends most of his time, while at home) that Dimitris can check and then reminds Dimitris a few minutes before the call. The coach then initiates the call with Dimitris' son.

Figure 5 Use case scenario depiction for persona Dimitris

3.1.3.3 Persona Fabio

CAPTAIN solution

Fabio wakes up (time configured by him or his family) and the coach informs him about the current date and presents weather information on the wall (e.g. cold temperature). After that it reminds him to take his morning medication. When Fabio sits relaxed in his couch the coach asks him if he wants to read a newspaper and project it on the wall. He can also hear some relaxing music while seeing photos of the trips he had done.

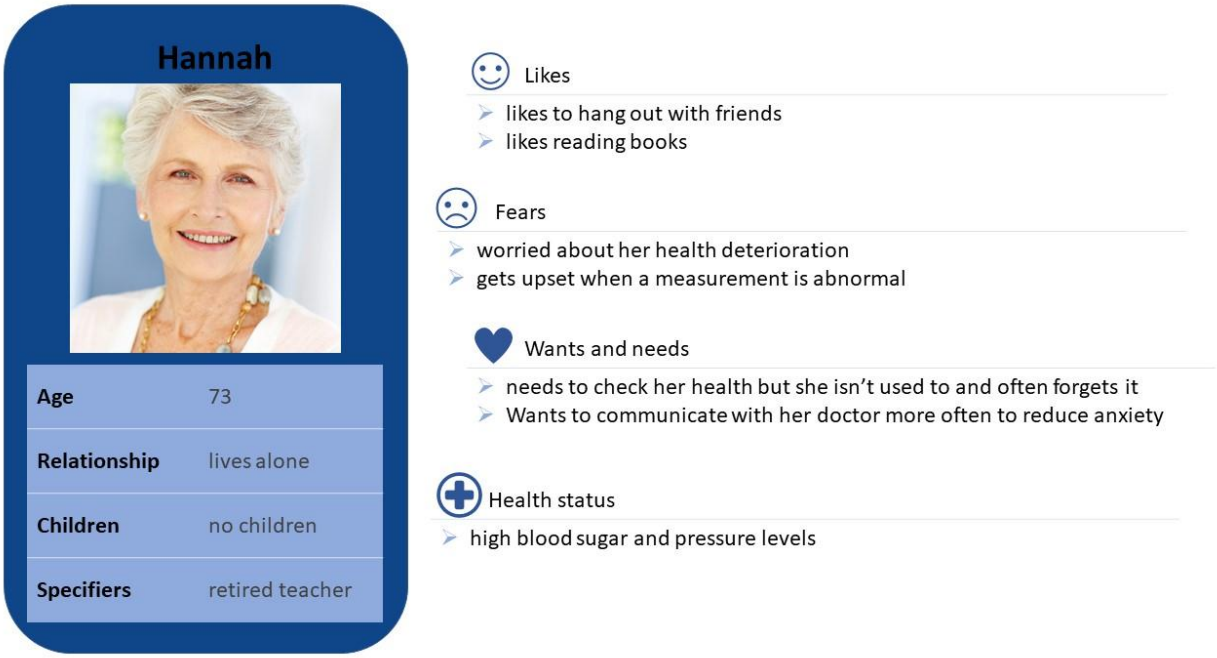
Also, coach suggests either to cook or order something to eat. Fabio decides to go out to have something to eat. Before he lives the house the coach projects a memo on the door to remind him to pick up keys, money, cell phone and his coat (maybe kept in a 'special box or case' that he uses to store his important possessions and to keep them where they can be easily found) and sends an alert to his daughters that he has left the house (Fabio and his daughters have given their permission for these alerts).

When Fabio returns home, the coach informs his daughter that Fabio has returned. The coach supports Fabio to hang his coat on the hook in the hall and to return his keys and money to his 'special box or case'.

Furthermore, the coach helps Fabio with notifications about useful memos as to turn of the gas or the heat.

Figure 6 Use case scenario depiction for persona Fabio

3.1.3.4 Persona Hannah



CAPTAIN solution

Hannah gets reminders for taking the medicine that has been subscribed by her doctor and for taking medical measurements. The coach helps Hannah by projecting visual instructions for how to use each medical device such as blood pressure. The coach stores the scores for Hannah's medical measurements automatically, that she can share with her GP in the next scheduled appointment if she wishes to.

Regarding the anxiety caused by abnormal measurements, the coach suggests repeating the measurement and if the measurements are above a certain limit, coach suggests calling her doctor and helps her to. (e.g. for blood pressure American Heart Association suggests: If your blood pressure readings suddenly exceed 180/120 mm Hg, wait five minutes and test again. If your readings are still unusually high, contact your doctor immediately).

Also, CAPTAIN has a mailbox for doubts about the results of their daily analysis that she can decide to share with her GP.

When coach detects that Hannah is in a bad mood or feels anxiety (negative emotion detection), suggests calling her friends and have some relaxing time

Figure 7 Use case scenario depiction for persona Hannah

3.1.3.5 Persona Maria

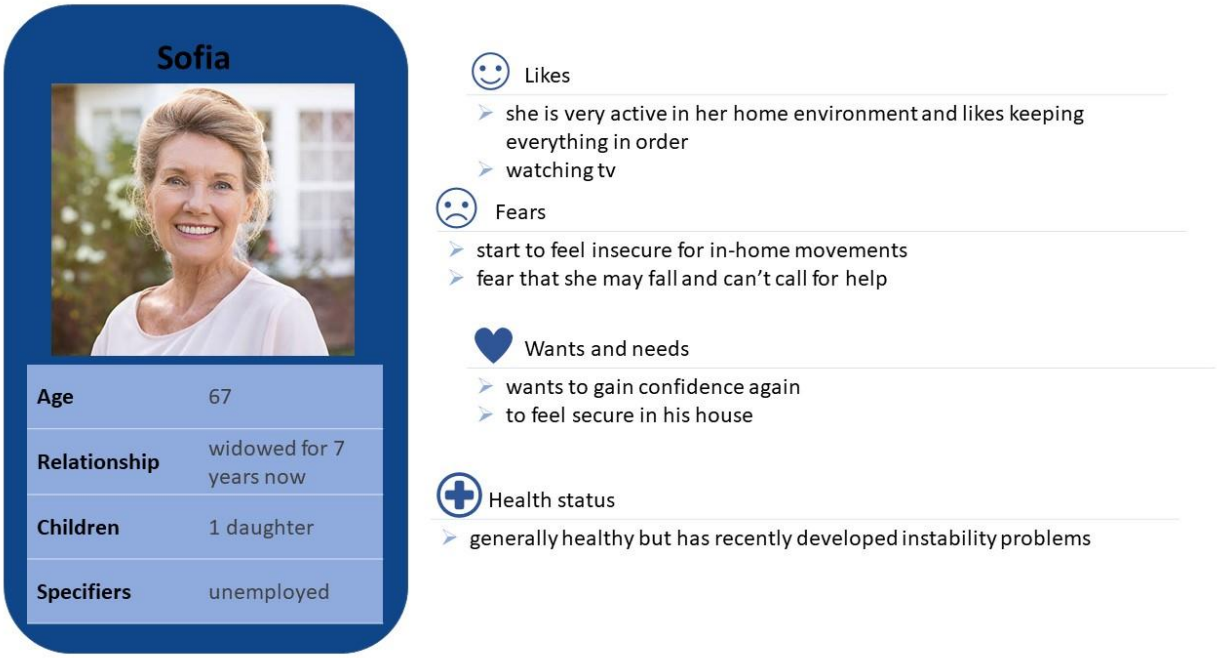
CAPTAIN solution

The coach helps Maria to decide what she wants to cook today, projecting several proposals based on a pre-defined nutrition plan specially designed for her. Maria can add new meals or decide to cook something else. Maria chooses a recipe and the coach helps her ensure that all the ingredients are available before she starts cooking (asks her for each ingredient and she replies positively or negatively). The coach projects each in the cupboards of her kitchen. When an ingredient is added, Maria informs the coach (oral) and if she forgets something the coach reminds it to her. Maria sits in the couch, relaxed knowing that the coach will inform her when the dinner is ready (the time has been predefined from the recipe. If Maria wants, she can add some extra time by informing the coach).

Notes: The plan for support in cooking can be adjusted. Different people will need different levels of support from just remembering ingredients to help to follow the right order of steps.

Figure 8 Use case scenario depiction for persona Maria

3.1.3.6 Persona Sofia



CAPTAIN solution

When Sofia moves in her house, the coach collects data from her moving patterns and it can detect a possible deterioration. The coach informs Sofia of local activities (cultural and/or sports) and events and provides motivation to participate and remain active. The coach motivates Sofia to go for a walk in the park nearby which can be a form of exercise.

CAPTAIN help Sofia avoid obstacles while moving in her house. Also, the coach can detect a possible fall or prolonged permanence on bathroom that indicates a fall and inform Sofia's daughter. This way Sofia feels safe and has gained some confidence.

Figure 9 Use case scenario depiction for persona Sofia

From the refined version of personas and user scenarios there were produced the following requirements:

Table 5 Requirements extracted from personas and user scenarios

Title	Description
Daily Weather Information	The system must provide information on daily weather conditions and forecasts
Physical training	The system must provide a solution for the user to exercise at home
Measurements self-management	The system suggests repeating the measurement and if the measurements are above a certain limit, the system suggests calling his/her doctor if it is essential
Meals instruction	Provide guidance and instructions on steps to follow to prepare a meal and the ingredients needed and help the user to identify if he/she has the ingredients needed
Coaching nutritional habits	The system must provide nutritional advice on replacing ingredients with healthier ones without losing flavor and reminders about the schedule of nutrition (proposed times)
Old photos	The system must give easy access to old photos of the trips he had done
Monitor the presence of barriers	The system must help the older adult to avoid obstacles while moving in his/her house and locate possible barriers and collisions with objects
Multimodal Interface	The system must accompany visual reminders with oral commands
Special case box	The system supports the user to store personal items in specific locations (e.g. special box for keys) to help him/her locate them easily.
Instruction on user's posture	The system must provide specific detail about the movements and body posture during exergames

during exercise	
Health Measurement coaching	The system must provide coaching advices in order to help the user remember when he/she must do a health-related measurement (e.g. blood pressure)
Proposing local activities	The system must detect and propose cultural and sport activities that take place in the local area and motivate the user to participate
Communication with relatives	The system must provide solutions that facilitate communication with relatives and friends (e.g. initiate video calls in scheduled time)
Social gaming	The system must help the user share information about his/her progress and achievements in exergame with other users on-line
Emergency handling	automatically alert (e.g. call) the appropriate/desired person to assist the older adult in case of fall
Import health-related data	Import health-related data collected by health monitoring devices automatically
Social Physical Exercise	The system must motivate the user to play/exercise with his/her friends (e.g. challenge them to gain more points)
Facial Emotional Recognition	The system must detect when the user is happy/sad/relaxed etc. in order to provide the appropriate suggestions
Emergency recognition	The system must inform the user when he/she has left an electric device (e.g. oven) open for a longer time than needed because that can cause a fire and provide useful memos as to turn of the gas or the heat
Gait analysis	The system must identify changes and anomalies in walking capacity
Detection of frailty	The system must detect frailty and possible deterioration in gait pattern
Exiting house reminder	The system must provide audio and visual reminders of the things that are essential for the user to bring with when going out
Social interaction	The system encourages the possibility of the user calling his/her friends and invite them to his/her home
Media use	The system must help the user to read the news from internet or (digital) newspapers

3.1.4 Requirements prioritization

Requirement prioritization is used for determining the components and features of the CAPTAIN technology, usually with the highest value for the end-users, to be included in the initial version. Prioritization is one of the most important aspects of any form of development work because choosing the right thing to do allows to maximize the value delivered. A common misconception among a developing team is that all identified requirements will be delivered and that results in prioritizing for the convenience of the technical team, putting easily achievable goals on top of the list. Consequently, some of the features dropped may be of greater value than those that are delivered. Even the architecture of the system, could be iteratively implemented and deliver in order to make sure that every time a functional system is delivered to the end-users. Contrary to the approach that is used in most of the projects, where the architecture implementation and the final components take too long to be delivered to the end-users, CAPTAIN minimizes the risk of disconnecting from the end-users by delivering all minimum functioning system (MVP) frequently.

As described above, the SCRUM product backlog methodology will be used. The backlog is a simple list with all things need to be done within the CAPTAIN technology creation. These items can be either user-centric or technology-based. Backlog is a living document that is constantly changing within the whole project. If needed, new requirements could be added and existing ones may be reprioritized or modified. Also, the existing requirements in the backlog shall not contain detailed information in terms of technical aspects.

In order to increase the transparency among all the involved parties (technical partners, pilot partners, dissemination and exploitation partners, stakeholders, older adults, etc.) and develop a trustful environment, when prioritizing requirements, it ensures that the project focuses on the most important elements first, and that everyone understands and agrees what the project's most important elements are.

The development team of CAPTAIN acknowledges that estimation of the effort and time needed to complete a given development goal, is also crucial. For this reason, it will strive to estimate it based on the knowledge of the first 2 iterations. This approach will effectively contribute to agile planning across different teams in CAPTAIN, meaning the planning while having the knowledge that these plans will be revised trough the course of the project. Those changes will be promoted by technical management of the project because, on the one hand a change, they will indicate that the development team will have learned something and it will help minimise mistakes. On the other hand, as it is indisputable that all the aspects of the CAPTAIN project cannot be predicted due to its complexity. Parkinson's law (Parkinson, 1955) states that: "Work expands so as to fill the time available for its completion". Therefore, the possibility of completing a task or goal earlier than the expected date is the slightest. Only by constantly planning and re-estimating, incorporating the knowledge that has been already obtained, the team will reach maximum productivity.

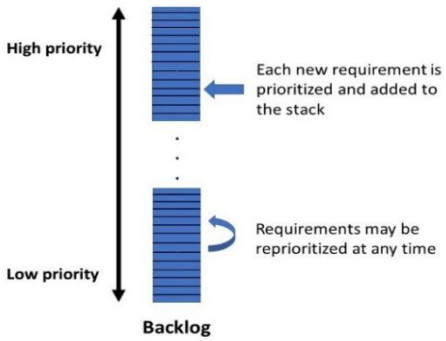


Figure 10 Backlog for SCRUM methodology

One way of prioritization is to rank requirements on an

ordinal scale, giving each one a different numerical value based on a predefined aspect. For example, the number 1 can mean that the requirement is the most important and the number *n* can be assigned to the least important requirement, with *n* being the total number of requirements. Given the difficulty of implementing this technique to a lot of stakeholders, another method is to assign a value at each requirement (e.g. from 1 to 3). This value can represent a lot of things but most commonly they refer to value and difficulty of implementation. The approaches used in this analysis are:

- **Value** – This approach focuses on the user's benefit of any given requirement; the requirements that will return the greatest value are given the highest priority.
- **Difficulty of Implementation** –a focus on difficulty of implementation places the highest priority on the requirements that are the easiest to implement. The benefit of this approach is that it allows a project to get some project benefits deployed quickly, enabling end-users and other stakeholders to become familiar with the project and give critical feedback before moving forward to deploy more difficult aspects of the project.

The requirements were ranked by each partner who assigned 2 values. The technical partners ranked the implementation risk, while partners with knowledge and experience from interaction with older adults ranked the value requirement.

Table 6 Requirements ranking scale

Parameter	Description	Levels
Value	How valuable will be for the user in case the requirement is implemented	High (3)
		Medium (2)
		Low (1)
Implementation risk	How great is the risk for the requirement not to be satisfied due to the maturity of the technology or restrictions of the available technology	High (3)
		Medium (2)
		Low (1)

When the technical and pilot partners have provided their estimation a mean value was calculated for both implementation value and implementation risk that are presented in the tables in the following section.

4 FIRST VERSION OF CAPTAIN USER REQUIREMENTS

4.1 FUNCTIONAL REQUIREMENTS

In this section we present the identified requirements that were included from literature research and the definition of personas and user scenarios. After defining the sources of information, the user requirements were abstracted and refined in order to meet the main objectives of CAPTAIN. Several categories were defined a priori taking into account the main tasks that would be delivered during the CAPTAIN system development. These categories are:

- **(B) Bio-parameters**: Related to components that measure or manage bio-parameters (e.g. blood pressure, heart rate). It is crucial for every e-coaching system to gather information from the user. Included are the requirements and use cases that describe how the system measures bio-parameters or the follow-up management in terms of storage and usage.
- **(C) Communication**: Related to communication with caregivers, friends, relatives etc. It includes description of use cases that enable, facilitate and manage the communication, motivate, propose and guide through new communication channels.
- **(I) Information**: Related to access to various information. CAPTAIN technology aims at facilitating user's access to various information that is widely available in the internet. The requirements describing how access will be enabled belong to this category.
- **(UM) User monitoring:** Related to user's unobtrusive monitoring. CAPTAIN system should gather information about the user to provide personalized coaching directions. This is done by monitoring components belonging in this category.
- **(EM) Environment monitoring:** Related to information about environmental parameters. Other than user monitoring, CAPTAIN system should monitor user's environment to enhance coaching advices.
- **(UG) User guidance:** Related to advices and recommendations done by the CAPTAIN system. Older adult guidance implements the basic coaching functionality of CAPTAIN. User requirements related to older adult guidance entail information gathered by older adult monitoring and environmental monitoring modules and support core functionalities as social engagements enhancement, physical and cognitive health maintenance.
- **(UI) User Interface:** Related to how the user interface should function. Basic module of CAPTAIN user's interface is the projected interface. Other modalities of user interface are also included in this category.

The requirements below include also an identification of the sources they came from (personas, EU projects and research papers).

FR.UM.01	
Category	User Monitoring
Title	Self report ADL
Source	MoveCare, inCasa
Description The system must provide a daily questionnaire to capture his/her activities of daily living.	
Value 1.44	Implementation risk 1.2

FR.UM.02	
Category	User Monitoring
Title	Monitoring in ADL
Source	APOLLO, ACANTO
	Persona Sofia
	(Mihailidis et al., 2008)
Description Monitor user body posture and gestures during ADL, detect changes of the user's capacity to perform activities of daily living and the successful completion of certain prompts in activities	

Value 2.88	Implementation risk 2.5

FR.UM.03	
Category	User Monitoring
Title	Emergency recognition
Source	iToilet, MoveCare, iStoppFalls, GrowMeUp, CaMeLi, FrailSafe, TERESA, Alfred, Guide, inCasa, DECI, APOLLO
	Persona Maria
Description Fall detection and general emergency recognition (e.g. forgetting to close the water or gas taps and accidental fire happen) provided by continuous monitoring	
Value 2.55	Implementation risk 2

FR.UM.04	
Category	User Monitoring
Title	Night wandering
Source	DECI, APOLLO
Description Tracking wandering, night wandering syndrome or any other abnormal displacement at night	
Value 2.22	Implementation risk 1.8

FR.UM.05	
Category	User Monitoring
Title	Risk of falls
Source	DECI, APOLLO
	Persona Sofia
Description The system must detect risk of falls by monitoring user's indoor movements in order to identify gaps and anomalies (change in walking speed, anomalies in gait patterns)	
Value 3	Implementation risk 2.4

FR.UM.06	
Category	User Monitoring
Title	Detection of frailty
Source	DECI, APOLLO
	Persona Sofia
Description The system must detect frailty by monitoring user's indoor movements in order to identify gaps and anomalies (change in walking speed, anomalies in gait patterns)	

Value 3	Implementation risk 2.4

FR.UM.07	
Category	User Monitoring
Title	Monitor Cognitive function I
Source	MoveCare, DECI
Description The system must achieve cognitive assessment and monitoring through the execution of (digital) neuropsychological tests	
Value 1.44	Implementation risk 1.75

FR.UM.08	
Category	User Monitoring
Title	Monitor Cognitive function II
Source	FrailSafe, DECI
Description The system must achieve cognitive assessment and monitoring through cognitive state-assessing game	
Value 1.88	Implementation risk 1.8

FR.UM.09	
Category	User Monitoring
Title	Monitoring in physical activities
Source	HEARTHMAN, GrowMeUp, ACANTO, i-PROGNOSIS, I-DONT-FALL, iStoppFalls, FrailSafe, Alfred
	Persona Carlo
	(Buttussi & Chittaro, 2008)(Klein et al., 2015)
Description Monitor user's body posture and gestures during exercise, monitor total 'amount' of exercise and physiological parameters (e.g. heart rate)	
Value 2.44	Implementation risk 1.66

FR.UM.10	
Category	User Monitoring
Title	Monitoring Sleep
Source	Guide, APOLLO
Description Staying too long in bed or getting up too many times during the night (e.g. to go to the toilet)	
Value 2.77	Implementation risk 1.8

FR.UM.11	
Category	User Monitoring
Title	Facial Emotional Recognition
Source	Miraculous life, GrowMeUp, TERESA
	Persona Hannah, Persona Fabio
Description The system should be able to analyze the facial expressions of the users in real-time	
Value 2.55	Implementation risk 2.33

FR.UM.12	
Category	User Monitoring
Title	Speech Emotional Recognition
Source	Miraculous life
Description Implement techniques for recognizing the emotions contained in the speech	
Value 2.11	Implementation risk 2.4

FR.UM.13	
Category	User Monitoring
Title	Behavioural monitoring
Source	CaMeLi, Miraculous life
Description The system should be able to detect sedentary life and general lack of activity (e.g. sitting for more than 3 hours)	
Value 3	Implementation risk 1.5

FR.B.01	
Category	Bio-parameters
Title	Import health-related data I
Source	HEARTMAN, FrailSafe, APOLLO
	Persona Hannah
Description Import health-related data collected by health monitoring devices automatically, (e.g. Weight, Blood pressure, Heart rate, Food intake, Exercise)	
Value 2.33	Implementation risk 2.5

FR.B.02	
Category	Bio-parameters
Title	Import health-related data II
Source	HEARTMAN, FrailSafe, APOLLO
Description Allow patients to store and note health-related data (e.g. Weight, Blood pressure, Heart rate, Food	

intake, Exercise) manually	
Value 1.66	Implementation risk 1.75

FR.C.01	
Category	Communication
Title	Social Physical Exercise
Source	Active@Home
	Persona Dimitris
	(Klein et al., 2015)
Description Game solution allowing users to play/exercise with others and provide social comparison ranking	
Value 2.22	Implementation risk 1.75

FR.C.02	
Category	Communication
Title	Social Cognitive Exercise
Source	HERMES, Alfred
Description The system should provide a way for different users to play cognitive games with other users and share information on-line	
Value 1.66	Implementation risk 2

FR.C.03	
Category	Communication
Title	Emergency handling
Source	iToilet, MoveCare, iStoppFalls, GrowMeUp, Alfred, CaMeLi
	Persona Sofia
Description Automatically alert (e.g. call) the appropriate/desired person to assist the older adult in case of emergency	
Value 2.66	Implementation risk 1.25

FR.C.04	
Category	Communication
Title	Facilitate communication
Source	CaMeLi, GrowMeUp, Alfred, APOLLO, ACANTO
	Persona Dimitris
Description Facilitate and enable user to use video, audio and text for communication with friends, family, caregivers etc.	
Value	Implementation risk

2.66	1.5

FR.C.05	
Category	Communication
Title	Making appointments
Source	HEARTHMAN, Alfred
Description Support patients in making appointments with caregivers, doctors etc. remind older adult when it's time to make an appointment for a regular check-up with a caregiver	
Value 2.33	Implementation risk 1.25

FR.C.06	
Category	Communication
Title	Virtual Community Platform
Source	HEARTHMAN, FrailSafe, GrowMeUp
	Persona Dimitris
Description Allow users to share self-monitoring data and/or exchange information (e.g. informing friends of what they are going to do, challenging users to play with him/her, share his/her achievements in exergames and being able to ask to join friends in activities) with friends, caregivers, peers, clinicians, family	
Value 2.22	Implementation risk 2.5

FR.C.07	
Category	Communication
Title	Display user's activity-plan
Source	ACANTO
Description Display activity-plans of users to specific others depending on user's desire and privacy profile	
Value 1.11	Implementation risk 1

FR.C.08	
Category	Communication
Title	Promote social interaction
Source	ACANTO, Alfred
Description Provides a mean to communicate and generate new friendships based on location and/or common interests	
Value 1.44	Implementation risk 2

FR.I.01	
Category	Information

Title	Agenda-system proposing daily activities
Source	CaMeLi, GrowMeUp, TERESA, Alfred, DECI
	Persona Sofia
Description System should provide information about events taking place in the area (cultural events or regarding physical exercises) and therefore propose activities for specific dates and time than would enhance older adult's socialization and physical capacity	
Value 1.33	Implementation risk 1.25

FR.I.02	
Category	Information
Title	Common calendar reminder functionality
Source	CaMeLi, GrowMeUp, TERESA, Alfred, APOLLO, HEARTMAN, ACANTO, GrowMeUp
Description Reminders for weekly activities, monthly payments, annual for birthdays	
Value 3	Implementation risk 1

FR.I.03	
Category	Information
Title	Daily Weather Information
Source	GrowMeUp
	Persona Fabio
Description Provide information on daily weather conditions and forecasts	
Value 1.88	Implementation risk 1

FR.I.04	
Category	Information
Title	Medication reminder
Source	MoveCare, CaMeLi, GrowMeUp, Alfred, DECI
	Persona Hannah
	(Kyriazakos et al., 2018)
Description The system must provide reminders for daily medication in order to increase adherence to treatment and occasional reminders related to individual needs such remind older adult when he/she should perform a specific health management task (e.g. request new medication prescriptions, updating medical file) or do a specific measurement (e.g. blood pressure)	
Value 2.66	Implementation risk 1

FR.I.05	
Category	Information

Title	Therapy monitoring
Source	Alfred
Description The user should be able to see whether he/she has already taken his/her pills in order to avoid overdose	
Value 2.11	Implementation risk 3

FR.I.06	
Category	Information
Title	Food and meals
Source	CaMeLi, GrowMeUp, Alfred
Description Information about general shopping list based on the menu of the week and nutrition plans	
Value 2.11	Implementation risk 1.75

FR.I.07	
Category	Information
Title	Exiting house reminder
Source	Alfred
	Persona Fabio
Description Remind the user with audio and visual instructions, on all the things he/she needs to bring with him/her when he/she leaves the house	
Value 2.55	Implementation risk 2.75

FR.I.08	
Category	Information
Title	Media use I
Source	Alfred
Description The system must assist the older adult to watch movies	
Value 1.33	Implementation risk 2

FR.I.09	
Category	Information
Title	Media use II
Source	Alfred, APOLLO
	Persona Fabio
Description The system must assist the older adult to get access to news and events of her/his interest	
Value 2	Implementation risk 1.75

FR.I.10	
Category	Information
Title	Personal data visualization
Source	FrailSafe, APOLLO, i-PROGNOSIS
	(Albaina et al., 2009)(Klein et al., 2015)(Beun et al., 2016)
Description Provide visualization of older adult data collected to give easily comprehensible personalized feedback (e.g. provide feedback of the progress in physical exercise)	
Value 2.33	Implementation risk 2

FR.I.11	
Category	Information
Title	Personalized Profiles
Source	GrowMeUp, HERMES, Alfred, Guide, PersonAAL
Description Enable the creation, maintenance and update of personalized profiles for older adults based on the monitored information, adaptable to different older adult needs, lifestyle and living environment	
Value 3	Implementation risk 2.25

FR.EM.01	
Category	Environment monitoring
Title	Finding objects I
Source	CaMeLi
	Persona Fabio
Description The system must keep the storage place of some personal belongings in a database, and long-term storage of items based on object recognition	
Value 2.22	Implementation risk 3

FR.EM.02	
Category	Environment monitoring
Title	Finding objects II
Source	MoveCare, GrowMeUp
Description The system must help the user locate objects or personal items based on their request and help him/her store them in a special location where it can be easily found	
Value 2.44	Implementation risk 3

FR.EM.03	
Category	Environment monitoring

Title	Monitor the presence of barriers
Source	Persona Sofia
Description The system must help the user to avoid obstacles while moving in his/her house and locate possible barriers and collisions with objects	
Value 2.77	Implementation risk 2.6

FR.UI.01	
Category	User Interface
Title	Verbal Interface I
Source	iToilet, TERESA, Alfred, Guide
Description The system must be controlled by spoken commands	
Value 2.77	Implementation risk 3

FR.UI.02	
Category	User Interface
Title	Verbal Interface II
Source	iToilet, MoveCare, Alfred
	Persona Carlo
	(Hudlicka, 2013)
Description The system must use voice guidance, the information must be provided to the user by speech technology and implement natural language dialogue	
Value 3	Implementation risk 1.8

FR.UI.03	
Category	User Interface
Title	Verbal Interface III
Source	Alfred
Description The system must listen to the older adult only by his/her command (e.g. by pushing a button)	
Value 1.33	Implementation risk 1.6

FR.UI.04	
Category	User Interface
Title	Emotional UI
Source	GrowMeUp, HERMES, RADIO
	Persona Fabio, Persona Carlo
Description	

Interface based on information about older persons' emotional state and speech characteristics provided by user monitoring	
Value 3	Implementation risk 2

FR.UI.05	
Category	User Interface
Title	Multimodal Interface
Source	GrowMeUp, HERMES, RADIO
	Persona Fabio
	(Hudlicka, 2013)
Description The oral given commands should be accompanied by visual clues and text information and vice versa	
Value 3	Implementation risk 2

FR.UI.06	
Category	User Interface
Title	Target spontaneous question
Source	Alfred
Description Initiate questions, in the domains of user's interest such as cinema, exhibitions, cooking, etc.	
Value 1.55	Implementation risk 1.2

FR.UI.07	
Category	User Interface
Title	Physical Training V
Source	Active@Home
Description There should be the possibility to exercise with music	
Value 2.33	Implementation risk 1.5

FR.UG.01	
Category	User Guidance
Title	Physical training I
Source	i-Prognosis
Description The physical exercise protocol must involve physical activity targeting full body exercise	
Value 2.55	Implementation risk 1.25

FR.UG.02	
Category	User Guidance
Title	Physical Training II

Source	I-DONT-FALL
	Persona Dimitris, Persona Carlo
Description Physical training programs at home are very convenient and highly proposed for older adults so the system must provide an in-home solution for physical exercise	
Value 2.88	Implementation risk 1.6

FR.UG.03	
Category	User Guidance
Title	Physical Training III
Source	i-PROGNOSIS, I-DONT-FALL, MyMate
	(Albaina et al., 2009)(Ellis et al., 2013)
Description Physical training program must include two to three days per week of exercises, no more than 30 minutes each, so the system should advice the older adult to exercise on a regular basis to do his weekly exercise and set specific goals to be achieved	
Value 1.55	Implementation risk 1

FR.UG.04	
Category	User Guidance
Title	Physical Training IV
Source	i-PROGNOSIS, I-DONT-FALL, Alfred
Description The system must provide a report on physical activity, showing training performance	
Value 2.66	Implementation risk 1.2

FR.UG.05	
Category	User Guidance
Title	Recommendation for fitness activities
Source	ACANTO, HEARTHMAN
	Persona Carlo, Persona Dimitris
	(Bickmore et al., 2009)(Ellis et al., 2013)
Description Recommend fitness-appropriate activities for older adults (e.g. motivate the older adult to walk more even for everyday activities)	
Value 2.88	Implementation risk 2

FR.UG.06	
Category	User Guidance
Title	Body and brain exercise
Source	Alfred
Description	

The system must engage the older adult in games that require the combination of mental and physical exercise	
Value 2.55	Implementation risk 2

FR.UG.07	
Category	User Guidance
Title	Coaching in physical activities I
Source	HEARTMAN, DECI
	(Buttussi & Chittaro, 2008)(Klein et al., 2015)(Beun et al., 2016)
Description Help older adults predict when they can and can't do an activity (e.g. taking into account recent/future activities, good/bad days etc. based on user monitoring), help older adult design a physical activity and exercise plan based on his/her profile information	
Value 2.88	Implementation risk 2

FR.UG.08	
Category	User Guidance
Title	Coaching in physical activities II
Source	HEARTMAN, Active@home, Alfred, MyMate, GrowMeUp, FrailSafe, INDEPENDENT
	Persona Carlo
	(Buttussi & Chittaro, 2008)
Description Advice on suitable intensity, duration and suitable time for physical exercise based on personalized needs and the correct completion of an exercise task e.g. Shortening durations, shortening distances, using lighter material, lowering intensity, using assistive tools, adjust speed	
Value 2.66	Implementation risk 2

FR.UG.09	
Category	User Guidance
Title	Meals instruction
Source	Persona Maria
Description Provide guidance and instructions on steps to follow to prepare a meal and the ingredients needed	
Value 2.22	Implementation risk 1

FR.UG.10	
Category	User Guidance
Title	Medication advice
Source	HEARTMAN
	Persona Hannah

Description Support older adult to organize medication to facilitate correct intake Provide strategies to create routines to facilitate correct intake	
Value 2.88	Implementation risk 2

FR.UG.11	
Category	User Guidance
Title	Cognitive exercise I
Source	MoveCare, GrowMeUp, FrailSafe, HERMES, MyMate, DECI
Description The system must engage the older adult in games that are entertaining while enhancing cognitive functions and memory training	
Value 2.22	Implementation risk 2

FR.UG.12	
Category	User Guidance
Title	Cognitive exercise II
Source	MyMate
	Persona Carlo
	(M. L. Lee & Dey, 2008)
Description The system must support older adult to look at old photos and capture new ones in order to stimulate memories and help the older adults recall and recollect more of the details of their experiences	
Value 2	Implementation risk 1.2

FR.UG.13	
Category	User Guidance
Title	Well-being self-management
Source	HEARTMAN
	Persona Hannah
	(McDonald et al., 2013)
Description Educate older adults about bodily signals they should be aware of that might indicate a physical problem and support decision upon repeating a measurement or taking the doctor's advice, help the older adult communicate his/her problem more efficiently	
Value 2.77	Implementation risk 1.8

FR.UG.14	
Category	User Guidance
Title	Health education
Source	HEARTMAN

	Persona Hannah
Description Prevent older adults from becoming hyper-aware/anxious of their condition due to frequent self-monitoring and give specific instructions about abnormal measurements (e.g. inform that this measurement is not worrying)	
Value 2.77	Implementation risk 1.8

FR.UG.15	
Category	User Guidance
Title	Coaching Sleeping problems
Source	(Kyriazakos et al., 2018)(Beun et al., 2016)
Description Support older adults to overcome sleeping problems (e.g. waking up, going to sleep, quality of sleep, and wandering)	
Value 2.66	Implementation risk 2.4

FR.UG.16	
Category	User Guidance
Title	Coaching Nutritional Habits
Source	HEARTMAN, GrowMeUp, Alfred, DECI
	Persona Maria
Description Provide nutritional advices and suggestions for recipes based on personalized needs, advice on replacing ingredients without losing flavor and timely reminders, avoid malnutrition	
Value 2.88	Implementation risk 2

FR.UG.17	
Category	User Guidance
Title	Social interaction reminder
Source	HEARTMAN, MoveCare, Alfred, DECI
	Persona Dimitris
Description Advice on staying in touch (taking initiative) with friends, support older adults in maintaining (or improving) their close relationships with family and friends by proposing and reminding activities involving the older adult's relatives and friends or encouraging to invite friends at home or for activities outside	
Value 2.88	Implementation risk 1.8

FR.UG.18	
Category	User Guidance

Title	Recommendation for activities
Source	ACANTO
Description Make recommendations for activities based on stored information about previously enjoyed activities and stated interests	
Value 2.77	Implementation risk 1.8

FR.UG.19	
Category	User Guidance
Title	Advice on user posture
Source	ACANTO, GrowMeUp, Active@home, Alfred
	(Mihailidis et al., 2008)(Buttussi & Chittaro, 2008)
Description Recommend that user changes posture during an ADL or detect prompts that are not performed correctly, give feedback to learn the right movements and posture and provide specific detail about the movements and body posture during exergames and exercise (e.g. safety advice)	
Value 2.33	Implementation risk 2.6

FR.UG.20	
Category	User Guidance
Title	Monitor acceptance or reject history
Source	ACANTO
Description Remember older adults' previous history of rejects and accepts in system's proposals in order to learn preferences	
Value 3	Implementation risk 1.2

FR.UG.21	
Category	User Guidance
Title	Measure Bio-signals
Source	MoveCare, HEARTMAN, Alfred, inCasa, Guide
	Persona Hannah
Description Support older adults to pay attention (measure frequently) to bio-signals (e.g measuring body weight, blood pressure)	
Value 2.88	Implementation risk 1.5

FR.UG.22	
Category	User Guidance
Title	Accept or reject recommendations
Source	ACANTO
Description	

Allow older adults to accept or reject recommendations	
Value 3	Implementation risk 1

FR.UG.23	
Category	User Guidance
Title	User technical support
Source	i-PROGNOSIS
Description The older adult must be able to request and receive help and technical support	
Value 3	Implementation risk 1

There's a constant struggle between high-risk and high-value. What should be done first? On one hand, if you avoid risky items and go for high-value first, you might develop a large part of the product before hitting a major roadblock. On the other, if you focus is placed on working on high-risk items first, it might end up with unnecessary work on features that turned out to be less valuable. The goal is to look for a balanced approach, going for High-risk/High-value first, Low-risk/High-value second and finally Low-risk/Low-value. High-risk/Low-value items should be avoided. Although this balanced approach will be a continuous task throughout the lifecycle of CAPTAIN (measuring, learning and optimizing), an initial view of the requirements that must be considered for implementation firstly is presented in Figure 11.

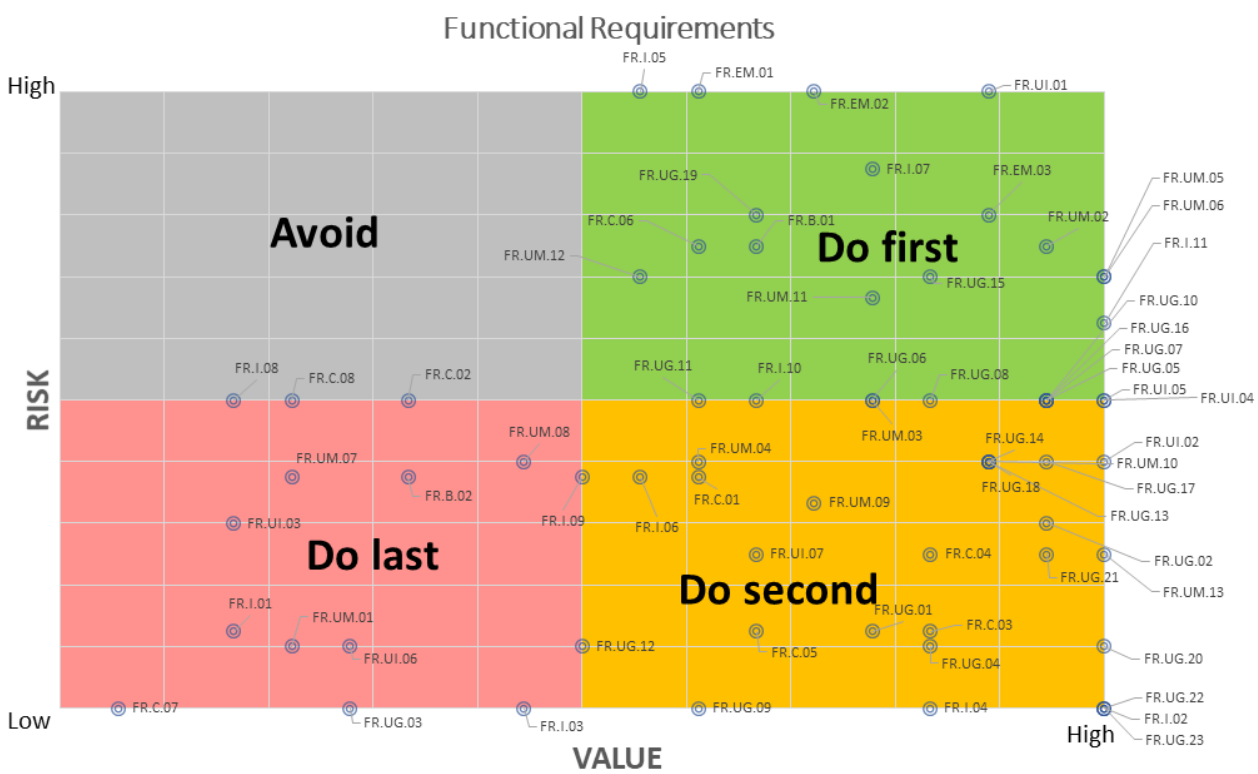


Figure 11 First view of user requirements considered for implementation

Given that in a Backlog (prioritized items to be developed), 2 items cannot have the same priority, a rough estimation of priority calculated by multiplying Value and Risk for each requirement follows in Table 7. This backlog will be transferred to trello (https://trello.com/) which is an online platform for efficient Agile task tracking.

FR.UI.01	8.3	FR.UG.10	5.8	FR.UM.09	4.1	FR.C.08	2.8
FR.EM.02	7.3	FR.UG.16	5.8	FR.UM.04	4.0	FR.I.04	2.7
FR.UM.02	7.2	FR.C.06	5.6	FR.C.04	4.0	FR.I.08	2.7
FR.EM.03	7.2	FR.UI.02	5.4	FR.C.01	3.9	FR.UM.07	2.5
FR.UM.05	7.2	FR.UG.08	5.3	FR.I.06	3.7	FR.UG.12	2.4
FR.UM.06	7.2	FR.UG.17	5.2	FR.UG.20	3.6	FR.UG.09	2.2
FR.I.07	7.0	FR.UM.03	5.1	FR.I.09	3.5	FR.UI.03	2.1
FR.I.11	6.8	FR.UG.06	5.1	FR.UI.07	3.5	FR.I.03	1.9
FR.EM.01	6.6	FR.UM.12	5.1	FR.UM.08	3.4	FR.UI.06	1.8
FR.UG.15	6.4	FR.UM.10	5.0	FR.C.02	3.3	FR.UM.01	1.7
FR.I.05	6.3	FR.UG.13	5.0	FR.C.03	3.3	FR.I.01	1.6
FR.UG.19	6.1	FR.UG.14	5.0	FR.UG.04	3.2	FR.UG.03	1.5
FR.UI.04	6.0	FR.UG.18	5.0	FR.UG.01	3.2	FR.C.07	1.1
FR.UI.05	6.0	FR.I.10	4.7	FR.I.02	3		
FR.UM.11	5.9	FR.UG.02	4.6	FR.UG.22	3		
FR.B.01	5.8	FR.UM.13	4.5	FR.UG.23	3		
FR.UG.05	5.8	FR.UG.11	4.4	FR.B.02	2.9		
FR.UG.07	5.8	FR.UG.21	4.3	FR.C.05	2.9		

Table 7 First Backlog of CAPTAIN functional user requirements

4.2 NON-FUNCTIONAL REQUIREMENTS

1. The different non-functional requirements identified have been grouped according to the eight-group ISO 25010 classification, as follows
   - **(QoS) Quality of Service**: what can the system provide to ensure that the service has high quality. It includes any component, use case requirement that aims at delivering a better overall service.
   - **(F) Functional suitability**: This characteristic represents the degree to which a product or system provides functions that meet stated and implied needs when used under specified conditions.
   - **(E) Performance efficiency**: This characteristic represents the performance relative to the amount of resources used under stated conditions.
   - **(C) Compatibility**: Degree to which a product, system or component can exchange information with other products, systems or components, and/or perform its required functions, while sharing the same hardware or software environment.
   - **(U) Usability**: Degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.

- **(R) Reliability**: Degree to which a system, product or component performs specified functions under specified conditions for a specified period of time.
- **(S) Security**: degree to which a product or system protects information and data so that persons or other products or systems have the degree of data access appropriate to their types and levels of authorization.
- **(M) Maintainability**: This characteristic represents the degree of effectiveness and efficiency with which a product or system can be modified to improve it, correct it or adapt it to changes in environment, and in requirements.
- **(P) Portability**: Degree of effectiveness and efficiency with which a system, product or component can be transferred from one hardware, software or other operational or usage environment to another

NFR.S.01	
Category	Security
Title	Possibility of oblivion
Source	ACANTO, APOLLO
Description Users should be able to withdraw themselves and their data at any time from the system for any reason	
Value 3	Implementation risk 1.5

NFR.S.02	
Category	Security
Title	Possibility to specify data to reveal
Source	ACANTO, Alfred, APOLLO
Description Users should be able to specify how much information they reveal and to whom	
Value 3	Implementation risk 2

NFR.S.03	
Category	Security
Title	User's data protection
Source	ACANTO
Description Users should be protected from revealing too much information about themselves	
Value 3	Implementation risk 2.5

NFR.S.04	
Category	Security
Title	User's data collection
Source	PersonAAL, APOLLO
Description Personal data should be easily accessible by the end-user, as well as possibilities for personal control	

by the end-user	
Value 2.7	Implementation risk 2

NFR.E.01	
Category	Performance efficiency
Title	Lag in the interface
Source	APOLLO
Description All interaction should get a feedback within 500 ms at most, to avoid the user experiencing delay	
Value 2	Implementation risk 2.4

NFR.M.01	
Category	Maintainability
Title	Software updates
Source	GrowMeUp
Description Updates and bug fixes should be performed on the server without distributing new versions of the software to users	
Value 2.5	Implementation risk 1.75

NFR.F.01	
Category	Functional suitability
Title	Real time exchange of information
Source	INDEPENDENT
Description Data base and exchange of information should be updated in real time	
Value 2.2	Implementation risk 1.75

NFR.F.02	
Category	Functional suitability
Title	No Cables
Source	Active@Home
Description Avoid the use of cables not to cause accidents	
Value 3	Implementation risk 1

NFR.F.03	
Category	Functional suitability
Title	Improved access to agendas and reminders
Source	HERMES
Description	

Any development must imply an advantage in comparison with their agendas, calendars etc. to be usable and accepted by older people. The system shall make it possible to provide this kind of free-form information and not restrict the user to forms and fixed inputs.	
Value 2.11	Implementation risk 2.5

NFR.F.04	
Category	Functional suitability
Title	Module cofiguration
Source	CaMeLi
Description the system has to be fully flexible and adjustable to the needs of each person and include only specific modules, modules can be turned on and off at any time.	
Value 3	Implementation risk 1.5

NFR.U.01	
Category	Usability
Title	Installation Process
Source	Alfred
Description The system must have anything pre-installed so that the user do not have to set up anything	
Value 3	Implementation risk 1.75

NFR.U.02	
Category	Usability
Title	Not invasive interface
Source	ACANTO
Description Interface must not irritate, distract or block view	
Value 2.88	Implementation risk 1.75

NFR.U.03	
Category	Usability
Title	Notifications off
Source	ISTOPPFALLS
Description The user needs to have the possibility to completely turn off notifications when he/she wants	
Value 2.28	Implementation risk 1.5

NFR.U.04	
Category	Usability
Title	System’s voice

Source	Alfred, Guide
Description the system must speak very slowly and clearly	
Value 3	Implementation risk 1

NFR.U.05	
Category	Usability
Title	Interface Layout
Source	RADIO
Description Only necessary items should be provided per working page. Do not include functions that are not necessary (e.g. system configuration item).	
Value 3	Implementation risk 2

NFR.U.06	
Category	Usability
Title	Icons/Glyphs
Source	RADIO
Description Standard/Self- explanatory icons intuitive visual items (icon and glyphs)	
Value 3	Implementation risk 1

NFR.U.07	
Category	Usability
Title	Text
Source	RADIO
Description Easy-to-read typography, concise text. Dark text on a solid light background, to allow all users to read easily. Large text size	
Value 2.88	Implementation risk 1.2

NFR.U.08	
Category	Usability
Title	Colors
Source	RADIO, Guide
Description Neutral Colors, use of red, yellow, and green as status indicators; globally consistent and culturally independent, intense color contrasts between the background and icons/text, the background should not be too dark or too bright because these colors make participants sight get tired easily	
Value 2.88	Implementation risk 1

NFR.U.09	
Category	Usability
Title	User Interface Simplicity
Source	i-Prognosis, I-DONT-FALL, Active@home
Description The user must be able to perform a task taking the minimum steps in the UI, not requiring to search a module by himself, the visual design/graphics has to be reduced to the essential adjusting to elderly people's abilities (not too much stimuli)	
Value 3	Implementation risk 1

NFR.U.10	
Category	Usability
Title	User Interface Adaptability
Source	Active@home, Alfred
Description The visual design/graphics has to be adjusted to user's abilities (e.g. using high visual contrast)	
Value 3	Implementation risk 1.2

NFR.R.01	
Category	Reliability
Title	Automatic self-check the most important features
Source	APOLLO
Description Automatic routines for detection of anomalies that may compromise functioning of the system	
Value 2.83	Implementation risk 2.25

NFR.QoS.01	
Category	Quality of Service
Title	System Responsiveness
Source	i-PROGNOSIS
Description The system must present an appropriate indicator when an action takes time to complete (e.g. loading bar)	
Value 2.33	Implementation risk 1

NFR.QoS.02	
Category	Quality of Service
Title	Multilingual platform
Source	i-PROGNOSIS
Description There must be versions of the platform in many languages	

Value 3	Implementation risk 1

NFR.QoS.03	
Category	Quality of Service
Title	Confirmation
Source	GrowMeUp, Guide
Description The system should ask for confirmation, whenever applicable, before performing an action (e.g. in emergency situation detection, the system should first ask the user if he/she needs help before informing the relatives)	
Value 2.77	Implementation risk 1.5

The non-functional requirements are just as critical as the functional ones. They ensure the usability and effectiveness of the entire system. Failing to meet any one of them can result in systems that fail to satisfy end-users regardless of the number of the functional requirements are implemented. Therefore, the main functionalities will be set as acceptance criteria for all the relevant functional requirements and the definition of "Done" for each of them. Therefore, since they do not provide functionality of the CAPTAIN system that will be delivered to the stakeholders, the prioritization presented here will be a guide for the technical partners where to focus initially.

NFR.S.03	7.5
NFR.R.01	6.4
NFR.S.02	6.0
NFR.S.05	6.0
NFR.U.05	6.0
NFR.S.04	5.4
NFR.F.03	5.3

NFR.U.01	5.2
NFR.U.02	5.0
NFR.E.01	4.8
NFR.F.04	4.5
NFR.M.01	4.4
NFR.QoS.03	4.2
NFR.F.01	3.9

NFR.U.10	3.6
NFR.U.07	3.5
NFR.U.03	3.4
NFR.QoS.02	3.0
NFR.F.02	3.0
NFR.U.04	3.0
NFR.U.06	3.0

NFR.U.09	3.0
NFR.U.08	2.9
NFR.QoS.01	2.3

Table 8 First Backlog of CAPTAIN non-functional user requirements

5 CONCLUSION

The main goal of this deliverable was to present the approach towards identifying the first version of user requirements for CAPTAIN system and the identified requirements. As the agile methodology will be used during the project, this is a living document that will be constantly readjusted based on the end-users feedback. For the first version of user requirements three different sources were used: EU funded projects, research studies and the consortium knowledge depicted in the personas and user scenarios. The part of this report described the methodology that was followed for the requirements identification while the second part was about the presentation and prioritization of the requirements.

This first set of functional and non-functional requirements of the CAPTAIN system have been identified based on the information gathered from two main sources: 1) study and analysis of literature coming from EU projects and research papers and 2) creation of personas and user scenarios that included

consortium's experience and end-user's feedback. A total of 24 EU projects was studied and from each one of them exclude the user requirements that are relevant to CAPTAIN's objectives and 16 research papers focusing on the e-coaching concept. Moreover, 6 personas were created along with the scenarios based on CAPTAIN system functionality and refined by the input of 5 stakeholders in total (older adults and caregivers).

Ultimately, 67 functional and 24 non-functional user requirements were identified in this first version of the analysis. As CAPTAIN has adapted an agile methodology the user requirements will change in the forthcoming months. The first meeting for CAPTAIN stakeholder community is set to be in M11 when the end-users will refine the user requirements in the first design thinking session and the requirements will keep changing through the project taking input from CAPTAIN community meetings that are described in D7.3 Pilot trials in living labs methodology and D7.1 Clinical study plan. Nevertheless, the current deliverable will contribute to the D2.2 First version of system specification and will be the main topic to discuss during the first sprint meeting.

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7 ANNEX 1: DESCRIPTION OF EU PROJECTS

Below we provide a short description of the projects studied in order to present the relevance with the CAPTAIN project and present the requirement elicitation mechanisms that were used. All projects have included end-users in the requirements elicitation process so they depict end-users' needs and wants.

Project	
i-PROGNOSIS 1/2/2016-31/1/2020 http://www.i-prognosis.eu/	***Description*** The main objective of the i-PROGNOSIS project is to design an ICT-based approach for early detection of Parkinson's disease and the design of ICT-based interventions to maintain and enhance the quality of older adults' life promoting active and healthy ageing.
	Requirement elicitation mechanisms Consortium face-to-face sessions, questionnaires, focus groups, interviews, web surveys
	Participants patients, carers, physicians, therapists, researchers, PD specialist nurses, neurologists, healthy older adults
I-DONT-FALL 1/4/2012-30/9/2015 http://www.idontfall.eu/	***Description*** I-DONT-FALL project aims at deploying, piloting and evaluating technological solutions for fall detection and prevention. The project's output is a platform integrating innovative technologies for fall management, balance training, fall prevention warnings and fall detection alarms.
	Requirement elicitation mechanisms Questionnaires, interviews, scenarios, use cases
	Participants Older adults and impaired citizens (stroke, dementia, chronic disease, secondary fallers), carers, medical professionals, researchers
FrailSafe 1/1/2016-31/12/2018 http://frailsafe-project.eu/	***Description*** FrailSafe projects aims to better understand frailty by collecting multiparametric data from older adult population. This data will help to identify quantitative and qualitative measures of frailty that will enable to predict outcome and risk of frailty. Furthermore, the system will provide interventions (real-time feedback, AR serious games) to reduce frailty onset.
	Requirement elicitation mechanisms questionnaires, focus groups and interviews
	Participants 102 older adults, 38 relatives, 45 health care professionals (medicine, nursing, physiotherapy, speech-Language Therapy, Social Work, Clinical and Cognitive Psychology, nutrition)
GrowMeUp 1/2/2015-31/1/2018 http://www.growmeup.eu/	***Description*** The GrowMeUp Project aims to provide a service robotic system that can learn from the user's needs and habits in order to assist and encourage older people to stay longer active, independent and socially involved, in carrying out their daily life at home.

	Requirement elicitation mechanisms questionnaires, focus groups and interviews
	Participants 16 older adults, 13 formal caregivers (care coordinators, nurses, psychologists, policy advisors, sociologist, ADL trainer, specialist older persons carer, 3 informal caregivers
MoveCare 1/1/2017-31/12/2019 http://www.movecare-project.eu/	***Description*** MoveCare develops an intelligent virtual caregiver embodied in a service robot that can provides assistance, cognitive, physical and environmental unobtrusive monitoring and personalized activities for socialization. MoveCare addresses to older adults and can be tailored each individual.
	Requirement elicitation mechanisms questionnaires
	Participants older adults (≥ 65 years), group of adults with MMSE ≥ 26, "pre-frail" according to Fried's Criteria, lived alone and no more than an average help of one hour a day for activities of daily living, caregivers, physicians
HERMES 1/1/2008-31/12/2011 http://www.fp7-hermes.eu	***Description*** HERMES provides an integrated approach to cognitive care. This is achieved through an assistive technology that combines the functional skills of the older person to reduce age-related decline of cognitive capabilities and assist the user where necessary. Based on intelligent audio and visual processing and reasoning, the project results in a combination of a home-based and mobile device to support the user's cognitive state and prevent cognitive decline.
	Requirement elicitation mechanisms Questionnaires, cultural probes, diaries, focus group, interviews, objective and subjective memory assessments
	Participants 96 older adults age 60+ with problems in ADL
HEARTMAN 1/1/2016-31/12/2018 http://heartman-project.eu	***Description*** HeartMan is a research project that is developing a personal health system to help congestive heart failure patients manage their disease. HeartMan will provide accurate advice on disease management adapted to each patient, and it will do so in a friendly and supportive fashion.
	Requirement elicitation mechanisms Perform a diary study containing 10 assignments for a period of 10 to 14 days. Interview study with semi-structured interviews of target users at their homes. Both studies were performed by 4 researchers in two countries (Belgium and Italy)
	Participants patients (with cardiac disease) assigned to either the diary only condition (n=6 in Belgium, n=3 in Italy), or to the diary & interview

	condition (n=14 in Belgium, n=16 in Italy).
ACANTO 1/2/2015-31/07/2018 http://www.ict-acanto.eu/	***Description*** The aim of the ACANTO project is to provide 3 system components to support the creation of a social network to support maintaining and increasing social groups; monitoring activities and making recommendations for future activities that maintain mobility and inclusion; provide a user-friendly/persuasive interface to network/walker and recommendations; create an activity program for delivery via a walker for rehabilitation activities and monitor progress.
	Requirement elicitation mechanisms Overarching requirements were agreed on by all the project team through discussion of key issues and based on an understanding of what can be achieved with current technology and the cost of the product. Information from stakeholders were also gathered through interviews.
	Participants first iteration of the requirements: older adults, rehabilitation clinics and rehabilitation patients (18 participants) Ten of them were interviewed in Italy (6 females, 4 males; age ranging from 65 to 102 years old, mean 75; 5 from rural areas, 5 from urban areas), and 8 in the UK (4 females, 4 males; age ranging from 60 to 87, mean 70, 8 from urban areas).
Active@Home 05/2016-04/2019 http://www.active-at-home.com/	***Description*** Active@Home is an interactive videogame-based training with dance and Tai Chi elements. The proposed solution, focusing on physical but also cognitive and social aspects, aims at promoting physical activity at home and foster fall prevention. The solution will be designed for large screens (TVs) through HDMI dongles and all exercises will be monitored using simple wearable motion sensors and guided by user-friendly virtual characters.
	Requirement elicitation mechanisms Questionnaires, focus groups with stakeholders, interviews with stakeholders
	Participants - 197 healthy independently living older adults aged 65 and older -Ergotherapist, Physiotherapist, Medical training therapist, Senior researcher in game design, senior researcher in dynamic healthy ageing, volunteer associations for the elderly, daily centers personnel, tai chi instructor for elderly

TERESA 11/2013-10/2016 https://teresaproject.eu	***Description*** The TERESA project aims at developing a telepresence robot with social intelligence, contributing advancing the deployment of robots in those settings that require substantial human interaction (e.g., homes, schools, hospitals). In telepresence systems, a human controller remotely interacts with people by guiding a remotely located robot, allowing the controller to be more physically present than with standard teleconferencing.
	Requirement elicitation mechanisms focus groups with End User Advisory Board (EUAB), questionnaires
	Participants 13 case studies with autonomous elderly to identify the sociological profile of the users, 6 ethnographic observations focusing on the interactions between the elderly and telecommunications devices, focus groups with 9 members, 13 semi-directed interviews
INDEPENDENT 01/2010-12/2012 http://independent-project.eu/home.html	***Description*** The goal of INDEPENDENT is to capitalize on information and communications technology (ICT) when it comes to supporting older people living in the community, to empower older people to maintain their independence. INDEPENDENT enables current support services to overcome limitations of sectoral telehealth and telecare service provision. It also empowers informal carers and voluntary/third sector to participate in delivery of support more effectively.
	Requirement elicitation mechanisms focus groups, questionnaires
	Participants 2 COPD patients,2 professional caretakers from the hospital, and 2 physiotherapists,4 nurses, 1 psychologist, 1 doctor, 4 technicians of e-health applications, 2 Salud Responde teleoperators, 2 nurses from Salud Responde and 2 FASS tele-assistants plus 2 FASS supervisor, 18 older adults aged 65+, 10 aged 50-59, 16 older adults
Care well 01/02/2013-31/01/2017 http://carewell-project.eu	***Description*** CareWell pursued the delivery of integrated healthcare to frail elderly patients through comprehensive multidisciplinary programs. ICTs facilitate the coordination and communication of healthcare professionals and support patient centered delivery of care at home. The two CareWell services consisted of two pathways supported by ICT: • integrated care coordination; and • patient empowerment & home support.

	Requirement elicitation mechanisms The initial point for requirements gathering in CareWell is to utilize experience from previous requirements gathering in other projects. Later, different people with different roles are provided with template where they can communicate their needs and particular design elements that are relevant for them.
	Participants patients and informal carers, healthcare professional's user requirements.
iStoppFalls 2011-2014 http://www.istoppfalls.eu	***Description*** The iStoppFalls consortium and project will develop an embedded AAL system that can predict and prevent falls by monitoring mobility-related activities and other risk factors of falls in real-life. Beyond continuous fall risk monitoring, this enables tailoring individualized exercise programs coached by iStoppFalls.
	Requirement elicitation mechanisms Interviews, workshops
	Participants 12 older adults (6 from Spain, 6 from Germany), age between 60-80, living in their own home, mixture of physical status (frail ,normal and active)
ALFRED 01/10/2013-30/09/2016 https://alfred.eu/	***Description*** It will allow older people to live longer at their own homes with the possibility to act independently and to actively participate in society by providing the technological foundation for an ecosystem consisting out of four pillars: -User-Driven Interaction Assistant -Personalized Social Inclusion -Effective & Personalized Care -Physical & Cognitive Impairments Prevention
	Requirement elicitation mechanisms The project initially focuses on the definition of the target group, identifying who the actual end-users of the ALFRED system would be, and what their main characteristics are. These characteristics are further analyzed with the help of existing research and literature, sketching a complete image of the end users in each of the pillars.
	Participants 24 Older adults, 6 formal and informal caregivers
Miraculous Life 12/2013-11/2016 http://www.miraculous-life.eu	***Description*** The aim of the Miraculous-Life project is to design, develop and evaluate an innovative user-centric technological solution, the Virtual Support Partner (VSP), attending to the elder (65+) daily activity and safety needs, while the elder goes about his normal daily life. The VSP will provide implicit daily activities support which is based on behavior and emotional understanding and

	appropriate respond exhibiting distinctive emotions, deliver in a human like way simulating in essence the interaction with a real-life partner.
	Requirement elicitation mechanisms Questionnaires, consultation and focus groups, literature study
	Participants 15 older adults, 22 caregivers (care coordinator, nurse, animation coordinator, physiotherapist, elderly care physician, nursing assistant)
Guide February 2010 -January 2013 http://www.guide-project.eu	***Description*** The project will develop a toolbox of adaptive, multi-modal user interfaces (UIs) that target the accessibility requirements of elderly users in their home environment, making use of TV set-top boxes as processing and connectivity platform beside the common PC platform.
	Requirement elicitation mechanisms literature review, quantitative data analysis of data from forums, user trials, user surveys, and questionnaires, qualitative analysis of observational data from user forums or interviews, video from user trials and usage ethnography, scenario focus group
	Participants Developers, older adults
CaMeLi February 2004 - February 2016 http://www.cameli.eu/site/	***Description*** CaMeLi is a project providing automated services with the purpose of assisting elderly people in their daily activities and assist in the provision of a comfortable quality of care. The CaMeLi project utilizes common tablet devices, installed in the living quarters of the user, with innovative avatar interfaces that can recognize the users' affective state and behavior as well as express emotions and other human-like behaviors. This virtual avatar thus assists in the daily activities of the elderly user and is able to aid in the care of the user through a Co-Care communication platform consisting of actual formal and informal human care-givers.
	Requirement elicitation mechanisms A series of interviews and paper based surveys were conducted with end users living in three different user contexts: VIVA (Independent elderly living at home in an urban setting, attending activities of the VIVA association), Orbis elderly home and Orbis care apartments.
	Participants older adults
iToilet April 2016 - October 2018	***Description*** The iToilet project addresses older persons who are living

http://www.aat.tuwien.ac.at/itoilet/	independently at home and the needs they have when using a toilet. The project aims at developing an ICT enhanced toilet system, which is able to empower older persons to live more independently and with increased dignity. iToilet also aims at reducing the workload of the care persons when providing personal assistance on the toilet. An existing height and tilt adjustable toilet module serves as base for adding several significant enhancements and services, e.g. control via voice, automatic recognition of and adaptation to user preferences when entering the toilet room, recognition of potentially dangerous situations (e.g. a fall) and other functionalities (e.g. interface to care documentation, providing guidance to persons).
	Requirement elicitation mechanisms focus group interviews
	Participants Primary users: above 60 years (for MS patients above 45 years) – 41 participants Secondary users: Professional caregiver, Informal caregiver that Spends at least four days a week with primary users – 21 participants Tertiary users: Professionals or people working in areas related to health care – 12 participants
RADIO 1/4/2015-31/03/2018 http://radio-project.eu/	***Description*** The aim of the RADIO project is to pursue a novel approach to acceptance and unobtrusiveness: a system where sensing equipment is not discrete but an obvious and accepted part of the user's daily life. By using the integrated smart home/assistant robot system as the sensing equipment for health monitoring, we divert the users' attention from the functionality of the sensors rather than from the sensors themselves. In this manner, sensors do not need to be discrete and distant or masked and cumbersome to install; they do however need to be perceived as a natural component of the smart home/assistant robot functionalities.
	Requirement elicitation mechanisms Background information, Observation, Personal Interview, Other
	Participants 30 older adults that have the ability to walk without human assistance indoors and need supervision in almost two instrumental Activities of Daily Living

MyMate November 2015 – November 2018 http://www.mymateproject.eu/	***Description*** MyMate project focuses on developing an innovative gamification approach capable of addressing the different needs of the individual elderly user, (e.g. medical, pharmaceutical, bio-monitoring and physical characterization, evaluation of emotional state, physical activity, leisure activities, etc.). MyMate aims at generating a novel elderly (primary) user-centered care paradigm involving the development and testing of an ICT-based solution in real life situations
	Requirement elicitation mechanisms Focus groups and questionnaires
	Participants 17 older adults living in their own homes, either alone or in couples
APOLLO 1/9/2017-31/8/2018	***Description*** within APOLLO, the goal is to extend the scope of MentorAge®, the product of Nively, that also belongs to the CAPTAIN consortium, through the creation of a consumer product line suitable for home use. The new product will be engineered starting from the existing MentorAge® B2B technology however, it will be targeted to the very different, yet promising, consumer market of people aged 60+.
	Requirement elicitation mechanisms interviews
	Participants 50 volunteers, healthy, older adults
DECI 1/6/2015-31/5/2018 http://deci-europe.eu/deciproject/	***Description*** DECI aims at designing and demonstrating a digital environment targeted at older adults with Cognitive Impairment, that will evolve traditional care models through the use of innovative technologies and algorithms. The system will improve a healthy lifestyle for the user passing through a system monitoring vital signs, treating and managing diseases and, in general, supporting the adoption of a healthy and independent lifestyle.
	Requirement elicitation mechanisms Co-creation workshops, literature study
	Participants professionals working in the field of care/cure and social support for older adults with cognitive impairment
inCASA 1/4/2010-3/6/2013 http://www.incasa-project.eu/news.php	***Description*** inCASA deals with user-centric technologies and public/private services network, to help and protect independent older adults that face frailty, prolonging the time they can live well in their own home by increasing their autonomy and self-confidence.

	Requirement elicitation mechanisms Questionnaire, workshop,
	Participants Older adults and health care professionals
PersonAAL 1/10/2015-1/10/2018 http://www.personaal-project.eu/	***Description*** PersonAAL aims at providing intelligent web applications enabling users to receive personalized assistance directly in their homes in order to improve quality of life, decrease healthcare delivery cost and extending the time older people can autonomously live in their home environment
	Requirement elicitation mechanisms web survey
	Participants 71 older adults aged 55-85

8 ANNEX 2: DESCRIPTION OF SCIENTIFIC PAPERS

Next table summarizes how the articles were found, in which search engine and with which tag to facilitate the replication of the searching. 16 papers were collected in total.

Table 9 Details for research papers studied

Reference	**Source**	**Year**	**TAG**
(Mihailidis et al., 2008)	Pubmed	2008	Virtual coach self-care
(Buttussi & Chittaro, 2008)	ACM	2006	Virtual coach self-care
(Bickmore et al., 2009)	Pubmed	2009	Virtual coach self-care
(M. L. Lee & Dey, 2008)	ACM	2008	Virtual coach self-care
(IJsselsteijn et al., 2006)	The MIT PressJournals	2006	Virtual coach self-care
(Albaina et al., 2009)	IEEE	2009	Virtual coach
(Kyriazakos et al., 2018)	Pubmed	2018	Virtual coach personalized
(French et al., 2008)	IEEE	2008	Virtual coach
(McDonald et al., 2013)	Pubmed	2013	Virtual coach health care

(Hudlicka, 2013)	Pubmed	2013	Virtual coach health care
(Woodward et al., 2017)	IEEE	2017	Virtual coach
(Hoof, 2017)	IEEE	2017	Virtual coach health behavior change management
(Ellis et al., 2013)	Pubmed	2013	Virtual coach
(Kamphorst, 2017)	ACM	2017	Coaching systems
(Klein et al., 2015)	IEEE	2015	Coaching systems
(Beun et al., 2016)	ACM	2016	Coaching systems

1. (Mihailidis et al., 2008)

This study examines the efficacy of a computerized device intended to assist people with dementia through ADL, while reducing caregiver burden. The device, called COACH, uses artificial intelligence to autonomously guide an older adult with dementia through the ADL using audio and/or audio-video prompts. Six older adults with moderate-to-severe dementia participated in this study. Handwashing was chosen as the target ADL. A single subject research design was used with two alternating baselines (COACH not used) and intervention (COACH used) phases. The data were analyzed to investigate the impact of COACH on the participants' independence and caregiver burden as well as COACH's overall performance for the activity of handwashing. Participants with moderate-level dementia were able to complete an average of 11% more handwashing steps independently and required 60% fewer interactions with a human caregiver when COACH was in use. Four of the participants achieved complete or very close to complete independence. Interestingly, participants' MMSE scores did not appear to robustly coincide with handwashing performance and/or responsiveness to COACH; other idiosyncrasies of each individual seem to play a stronger role. While the majority (78%) of COACH's actions were considered clinically correct, areas for improvement were identified. The COACH system shows promise as a tool to help support older adults with moderate-levels of dementia and their caregivers. These findings reinforce the need for flexibility and dynamic personalization in devices designed to assist older adults with dementia. After addressing identified improvements, the authors plan to run clinical trials with a sample of community-dwelling older adults and caregivers.

2. (Buttussi & Chittaro, 2008)

Sports and fitness are increasingly attracting the interest of computer science researchers as well as companies. In particular, recent mobile devices with hardware graphics acceleration offer new, still unexplored possibilities. This paper investigates the use of mobile guides in fitness activities, proposing the Mobile Personal Trainer (MOPET) application. MOPET uses a GPS device to monitor user's position during her physical activity in an outdoor fitness trail. It provides navigation assistance by using a fitness trail map and giving speech directions. Moreover, MOPET provides motivation support and exercise demonstrations by using an embodied virtual trainer, called Evita. Evita shows how to correctly perform

the exercises along the trail with 3D animations and incites the user. To the best of our knowledge, our project is the first to employ a mobile guide for fitness activities. The effects of MOPET on motivation, as well as its navigational and training support, have been experimentally evaluated with 12 users. Evaluation results encourage the use of mobile guides and embodied virtual trainers in outdoor fitness applications.

3. (Bickmore et al., 2009)
Work towards the development of a handheld health counseling agent designed to promote physical activity is described. Previous work on automated health counselors is discussed, along with the affordances of mobility and context awareness for health behavior interventions. We present a general-purpose software architecture for the rapid design and deployment of mobile health counseling agents. We also describe the results of an initial field trial in which such a mobile agent plays the role of an exercise coach designed to motivate users to walk more. Results were mixed. We found that the context awareness mechanism that was implemented for detecting walking led to greater user-agent social bonding, but less walking in study participants.

4. (M. L. Lee & Dey, 2008)
Lifelogging technologies have the potential to provide memory cues for people who struggle with episodic memory impairment (EMI). These memory cues enable the recollection of significant experiences, which is important for people with EMI to regain a sense of normalcy in their lives. However, lifelogging technologies often collect an overwhelmingly large amount of data to review. The best memory cues need to be extracted and presented in a way that best supports episodic recollection. We describe the design of a new lifelogging system that captures photos, ambient audio, and location information and leverages both automated content/context analysis and the expertise of family caregivers to facilitate the extraction and annotation of a salient summary consisting of good cues from the lifelog. The system presents the selected cues for review in a way that maximizes the opportunities for the person with EMI to think deeply about these cues to trigger memory recollection on his own without burdening the caregiver. We compare our system with another review system that requires the caregiver to repeatedly guide the review process. Our self-guided system resulted in better memory retention and imposed a smaller burden on the caregiver whereas the caregiver-guided approach provided more opportunities for caregiver interaction.

5. (IJsselsteijn et al., 2006)
The current paper describes research that is aimed at elucidating our understanding of media technology factors that may help users of exercise equipment to stay motivated for doing regular workouts. In particular, we investigated the effects of immersion and coaching by a virtual agent on intrinsic motivation and the sense of presence of participants cycling on a stationary home exercise bike. A basic two-by-two within-subjects experimental design was employed whereby participants were presented with a virtual racetrack with two levels of immersion (high vs. low) and two levels of a virtual coach (with vs. without). Results indicate a clear positive effect of immersion on both motivation and presence. The virtual coach significantly lowered the perceived control and pressure/tension dimensions of intrinsic motivation, but did not affect the enjoyment dimension. The presence of the virtual coach also reduced negative effects associated with VEs, such as feeling dizzy or nauseated.

6. (Albaina et al., 2009)

The use of context-aware technology in the home enables new ways to stimulate elderly in increasing their exercise levels, and consequently prevent age-related health issues amongst an increasing elderly population. This paper describes the design of a persuasive virtual coach that encourages seniors to walk more. In order to incorporate the user values and needs in the design concept, a user panel of elderly people was actively involved in the design process. A range of persuasive principles and interaction metaphors were evaluated with the user panel, resulting in a design concept that was approved and appreciated by the user panel. The design concept combines a pedometer with wireless connectivity with a touch-screen photo frame. As a first step towards a longer evaluation, an experimental prototype was tested in the field with two participants for 11 days each. Whereas the participants of the exploratory intervention did appreciate the virtual coach and they did feel more motivated to exercise, the quantitative figures did not yet show an increase in physical activity in time; a possible explanation could be the limited activity-sensing capabilities of the prototype in combination with the changing weather conditions in the course of the user study. Furthermore, the participants would like to see a system with a better awareness of the context of use, such that the system can better select the right timing for motivational cues. These findings will be used to improve the design concept and perform a longitudinal user study in the field.

7. (Kyriazakos et al., 2018)

Well-being of cancer patients and survivors is a challenge worldwide, considering the often chronic nature of the disease. Today, a large number of initiatives, products and services are available that aim to provide strategies to face the challenge of well-being in cancer patients; nevertheless the proposed solutions are often non-sustainable, costly, unavailable to those in need, and less well-received by patients. These challenges were considered in designing FORECAST, a cloud-based personalized intelligent virtual coaching platform for improving the well-being of cancer patients. Personalized coaching for cancer patients focuses on physical, mental, and emotional concerns, which FORECAST is able to identify. Cancer patients can benefit from coaching that addresses their emotional problems, helps them focus on their goals, and supports them in coping with their disease-related stressors. Personalized coaching in FORECAST offers support, encouragement, motivation, confidence, and hope and is a valuable tool for the wellbeing of a patient.

8. (French et al., 2008)

We introduce the concept of a Virtual Coach (VC) for providing advice to manual wheelchair users to help them avoid damaging forms of locomotion. The primary form of context for this system is the user's propulsion pattern. The contexts of self vs. external propulsion and the surface over which propulsion is occurring can be used to improve the accuracy of the system's propulsion pattern classifications. To obtain these forms of context, we explore the use of both wearable and wheelchair-mounted accelerometers. We show achievable accuracy rates of up to 80-90% for all desired contextual information using two common machine learning techniques: k-Nearest Neighbor (kNN) and Support Vector Machines (SVM).

9. (McDonald et al., 2013)

There is a need to enhance patient and practitioner pain communications. A pain communication plus virtual pain coach intervention was tested in the primary care setting for the effect on communication of osteoarthritis pain information by older adults aged ≥60 years, on practitioners' pain management changes, and on older adults' reduced pain and depressive symptoms 1 month later. A randomized controlled pilot study design was used. Twenty-three older adults with osteoarthritis pain were

randomly assigned to the pain communication plus virtual pain coach group or the pain communication-only group. Pain communication consisted of a video of important osteoarthritis pain information. The coach consisted of practicing out loud with a virtual pain coach via laptop computer. Pain and depressive symptoms were measured with, respectively, the Brief Pain Inventory Short Form and the Beck Depression Inventory II before intervention and 1 month later. Immediately after the intervention, older adults had their primary care visits, which were audiotaped, transcribed, and content analyzed for older adults' communicated pain information and practitioners' pain management changes. Older adults in the pain communication plus virtual pain coach group described significantly more pain source information and were prescribed significantly more osteoarthritis pain treatments than older adults in the pain communication-only group. A nonsignificant trend in pain intensity and depressive symptoms reduction resulted for older adults in the pain communication plus virtual pain coach group 1 month later. The virtual pain coach presents a possible strategy for increasing pain management discussions between practitioners and older adults with persistent pain.

10. (Hudlicka, 2013)
The objective of this research was to develop and evaluate a Virtual Mindfulness Coach for training and coaching in mindfulness meditation. The coach was implemented as an embodied conversational character, providing mindfulness training and coaching via mixed initiative, text-based, natural language dialogue with the student, and emphasizing affect-adaptive interaction. (The term 'mixed initiative dialog' refers to a human-machine dialogue where either can initiate a conversation or a change in the conversation topic.). Findings from a pilot evaluation study indicate that the coach-based training is more effective in helping students establish a regular practice than self-administered training using written and audio materials. The coached group also appeared to be in more advanced stages of change in terms of the transtheoretical model, and have a higher sense of self-efficacy regarding establishment of a regular mindfulness practice. These results suggest that virtual coach-based training of mindfulness is both feasible, and potentially more effective, than a self-administered program. Of particular interest is the identification of the specific coach features that contribute to its effectiveness. Practice Implications—Virtual coaches could provide easily-accessible and cost-effective customized training for a range of health behaviors. The affect-adaptive aspect of these coaches is particularly relevant for helping patients establish long-term behavior changes."

11. (Woodward et al., 2017)
Successful prosthesis use is largely dependent on providing patients with high-quality, individualized pre-prosthetic training, ideally completed under the supervision of a trained therapist. Computer-based training systems, or 'virtual coaches,' designed to augment rehabilitation training protocols are an emerging area of research and could be a convenient and low-cost alternative to supplement the therapy received by the patient. In this contribution we completed an iterative needs focus group to determine important design elements required for an effective virtual coach software package.

12. (Hoof, 2017)
Imec has launched a virtual personal health coach research program which combines wearable technology and data sciences for providing new coaching methodologies towards managing an active lifestyle, managing stress, and smoking cessation, with the ambition to have a big impact on preventive health and reduce the future incidence of chronic disease. Chronic diseases currently account for 70 to 85% of all healthcare costs in US, EU and OECD countries. Nearly half of these chronic diseases are linked to lifestyle and behavior and are therefore in principle preventable. At the same time, we are

creating a next generation of chronic patients when looking at behavioral statistics of adolescents and adults. A third of all adolescents and half of all adults are not sufficiently active (in terms of aerobic exercise and physical activity). Nearly three quarters does not meet the recommended targets for muscle-strengthening physical activity. We consume too much sodium (which increases our risk of hypertension). Nearly 25% (40%) of adults said they ate vegetables (fruit) less than once a day. Approximately 19% of all adults still smokes cigarettes and e-cigarettes are on the rise. Half of all alcohol-related deaths are due to binge drinking. Unhealthy behavior leads to high blood pressure and high LDL cholesterol which are risk factors for heart disease and stroke. A major effort should therefore be devoted to preventive health and focus on maintaining or restoring a healthy lifestyle. Consumer wearables are already aiming to address our behavior, most notably fitness, and to some extent diet. However, since changing behavior is so difficult, generic smartphone apps providing averaged advice are not well accepted by users and have limited positive outcomes. If wearables were to learn our habits, and were able to capture triggers towards bad behavior, they could provide the right positive advice at the right time. Doing so, they could have the same impact and high-quality result as a personal coach who learns our behavior, what motivates us and gives tailored personalized advice

13. (Ellis et al., 2013)

The short-term benefits of exercise for persons with Parkinson Disease (PD) are well-established, but long-term adherence is limited. The aim of this study was to explore the feasibility, acceptability and preliminary evidence of effectiveness of a virtual exercise coach to promote daily walking in community dwelling persons with PD. Design—twenty subjects with PD participated in this Phase I single group, non-randomized clinical trial. Subjects were instructed to interact with the virtual exercise coach for 5 minutes, wear a pedometer and walk daily for one month. Retention rate, satisfaction and interaction history were assessed at 1-month. Six-minute walk and gait speed were assessed at baseline and post intervention. Participants were 55% female, mean age 65.6. At study completion, there was a 100% retention rate. Subjects had an average satisfaction score of 5.6/7 (with seven indicating maximal satisfaction) with the virtual exercise coach. Interaction history revealed that participants logged- in an average of 25.4 days (SD 7) out of the recommended 30 days. Mean adherence to daily walking was 85%. Both gait speed and the 6-minute walk test significantly improved ($p<0.05$). No adverse events were reported. Sedentary persons with PD successfully used a computer and interacted with a virtual exercise coach. Retention, satisfaction and adherence to daily walking were high over one- month and significant improvements were seen in mobility.

14. (Klein et al., 2015)

Engaging in sufficient physical activity has several beneficial effects on physical and mental health. Still, a large proportion of the Western population doesn't meet the guidelines of being moderately to vigorously active for a minimum of 30 minutes on at least five days a week. Mobile technology provides possibilities for personalized coaching systems, and the results of existing mobile interventions look promising. Here, the authors present a mobile system that goes beyond existing (mobile) physical activity interventions. The approach combines theory and evidence-based behavior-change techniques with a model-based reasoning system, to provide the right support and strategies at the right time for obtaining a physically active lifestyle.

15. (Beun et al., 2016)

Non-adherence is considered a problem that seriously undermines the outcome of behavior change therapies, in particular of self-help therapies delivered without human interference. This paper presents the design rationale behind a computer system in the domain of adherence enhancing strategies in automated e-coaching. A variety of persuasive strategies is introduced and implemented in a mobile e-coaching system in the domain of insomnia therapy. The system integrates two types of interface elements, i.e. dedicated tools and natural language conversation, to simplify therapy related activities and to include social strategies to improve motivation. We focus on the crucial role of communication and adaptation.

9 ANNEX 3: END USER CONSULTATION FROM AUTH

Procedure: A facilitator showed the presentation with the personas created for the project to a woman 68-year-old along with oral explanation and discussed with her different aspects. Another facilitator was taking notice of the discussion. The whole procedure lasted for about 30 minutes.
General comments: The senior participant interviewed is familiar with using technology in her everyday life as she has a smartphone and a tablet. The main fear/complaint she expressed is that extended use of technology might isolate elderly and reduce the human interaction. She pointed out that the system must be personalized, some solutions do not fit in every condition. Also, at first, she had a hard time adapting to the idea of projections. She kept referring to the technology as screen.
Personas:
Generally, she was able to match every person with a familiar one and understand the character and the proposed solution. More specifically,

1. Carlo
She found very helpful to exercise through games projected on the wall but point out that this must not exclude the visits from a physiotherapist. When she was asked about the type of instructions (voice or written text) that would fit more in the scenario, she replied that both would be the best. If his attention is distracted from the text, the voice could help him focus.

For the slide with the photo Carlo send to his daughter, the interviewed senior said “It can be annoying. The only thing the daughter wants to know is that her father is healthy and happy and she may do not want to exchange pictures. “

2. Maria
About the detailed recipe projected on the cupboards, the interviewed stated that could be too much information that end up being annoying. Only the recipe projected on the wall can be sufficient for MCI. It is not that important to hear every ingredient or every step.

The scenario which the coach informs Maria that she must turn off the oven was well approved. She said that “This is the most important. Even if you do not have any health problems, after 60-65 years old, we forget to turn off the hotplate. This has to be applied for the Alzheimer’s, too. The system must inform her how much time has passed, she would then check and say how much more she needs.”

3. Hannah
The screen for the instructions may not be necessary if Hannah doesn’t have memory problems, said the interviewed woman. However, the projection with the daily measurements may be helpful and it would be safer to be send to a doctor.

However, she wondered if there is a doctor that would do check everyday measurements and suggests as a better solution for each patient to be able to show the measurements to their doctor during an appointment.

4. Fabio

She found the overall illustration helpful and she pointed out that the temperature might be confusing because he wouldn't know if it is referred to internal temperature or temperature at the outside environment.

She told that the memos are very useful but they must depend on the weather (e.g. no coat in the summer). She suggested the icons to be replaced with words. The alert is indispensable.

5. Sofia

Only a bright sign when she approaches an obstacle will be enough for Sofia. The alert send to their children is the most important. She found the picture with Sofia in her bedroom a little confusing.

6. Dimitris

The contact through the exergame platform was not a convincing scenario for the interviewed senior. She said that it would be better if he just calls his friends but she thought that the idea of projection for the skype call is very interesting. "Even if he knows how to use skype, it would be better with the projection. It is like they are in front of you in real size."

10 ANNEX 4: END USER CONSULTATION FROM INTRAS

Procedure: A facilitator showed the presentation with the "personas" created for the project to a 69 years old senior woman (with MCI) along with oral explanation and discussed with her different aspects. Another facilitator was taking notes of the discussion. The whole procedure lasted for about 40 minutes.

General comments:

- Use of technology (basic mobile phone, TV, computer) but not anymore with a proficient level.
- Showing some difficulties in the choice of words and concretizing. Good humor and good social skills.
- In the mentioned coping strategies, she is implementing currently, there is not a particular focus in the use of technology; however, some of the strategies have potential to be transferred to a scenario mediated by technology. No specific fears on the use of technology although sometimes sceptic on its use if substituting personal coping mechanisms and personal effort to remember and be autonomous. In that aspect, CAPTAIN needs to adapt to personal coping schemes.

Personas:

- Adequate understanding of the described cases but difficulty in maintaining focused. She needed support for maintaining the narrative on the discussed aspects (for example, she begun to describe different situations that can happen with a person with diabetes but without relating that information with the presented scenario).
- She understood well the character of the proposed solution. Notes taken based on direct "insights" and subjective understandings re-elaborated and validated with her.

1. Carlos

- <u>Advantages/likes:</u> possibility of a motivational approach for continuing the physical training at home (in a secure environment) as a complementary action to the regular physiotherapeutic

sessions. Ensures a preventive opportunity once those treatments are limited in time and, sooner than later, the person will finished the co-funded physical therapy (as is usual in the public services). She was excited with the possibility of seeing real images of enjoyable places.

- Highlighted relations: hip fracture may be an occurrence justified by preventable conditions such as osteoporosis, or related with a sedentary life, that are commons aspects affecting many elderly people, and so, she sees it as a generally interesting functionality for everybody, not just after a "crisis".
- Requirements: customization of the scenarios, motivational approach as most as possible based on person preferences and interests (example given of a "medicine" being prescribed by GP's for improving general health and wellbeing – caring for a dog with all the activities that this decision requires).

Insights & Suggestions of professionals:

Priority to use scenarios of nature as a source of inspiration, aesthetic delight, relaxation, well-being, used in healing processes, behavioral adjustment and creativity (Thomas JL, 2016). As evidenced by different studies (e.g. attention restoration theory, Kaplan and Kaplan 1989), the use of nature-centered scenarios has the potential to restore energy and direct attention. Real or virtual contact with nature environments improves cognitive performance, helping recovery and improving the overall well-being of the person (especially if the person spends much of his/her time indoors). In this sense, the use of a dynamic experience with 360º scenarios of nature will be key to the required effect once nature is full of stimuli and patterns for personal exploration without specific requirements.

- In this case, CAPTAIN has forgotten to tell Carlos the possibility of calling his friends so that they could be with him at home that afternoon since he could not go out and invite them to the "virtual tour" that Carlos needs to do for his recovery. The presence of people close to us in difficult times giving us support in requested task, may lead to a faster recovery.

2. Maria

- Advantages/likes: opportunity for maintaining independency by ensuring support and an adequate performance cooking.
- Highlighted relations: relations made with her personal strategies cooking due to her memory problems. Implemented strategies: use of a chronometer in her pocket when she is cocking; notebook with simple meals (with ideal portions for one person) used to review the order of steps and ensure all the ingredients are well positioned in the table before start cooking.

It is important that the system help the person to break the cognitive automatisms, to gain conscience on each task (e.g. for example, when the person is turning off a cooking device automatically and without realizing it, once this may lead to doubts later whether it has been turned off or not).

- Requirements: different people will need different levels of support from just remembering ingredients to help to follow the right order of steps. Importance of a balance diet and different meals for which is important to have the possibility to add easily different meals the person can be interested in.

Insights & Suggestions of professionals:

- Doubts of the professionals: How does Maria inform Captain? The best way is to say it out loud: I'm pouring the oil. Is this the way? Or will you have to go to a panel to choose an option? What if she forgets what she has to do in between to inform CAPTAIN about the last steps done? Or is there an image recognition system?
- May be important to have the decision on the meal some time before, to help people to confirm if they have the ingredients and necessary portions or if they need to buy. CAPTAIN can help the person to make the supermarket list (recording and afterword's showing the images or audio of the list before the person to proceed going out to buy). Can also be made a link to home delivery services.

- If the system detects the performance of steps and use of ingredients through the person verbalization (e.g. focused on the keywords the person may need to verbalize such as step 1 "done!") this means that most probably the person need to receive training. The system may help repeating instructions (e.g. asking the person after 1 minute of absence of feedback – the specific keyword programmed to detect - "if you have performed this step say: Done!").
- Customized level and format of instructions (e.g. with audio, without, step by step / ingredient by ingredient or a full list if no major support is required).

3. Hannah

- Advantages/likes: such kind of support is interesting but is not seeing as something new. She is already doing this, sharing data of the blood sugar measurements with her GP. However, for a recently diagnosed person can be a good support, making the condition management easier.
- Highlighted relations: recommendation to include a function of help in the diet management (predetermined by a health professional and adequate for the control of fats and sugar) given the great relation with diabetes (metabolic condition).
- Requirements: not only consider the medical recommendations but also personal preferences and needs (e.g. person with blood sugar lowering crisis may need to make controls when he/she do not feel ok, not just in the "prescribed" moments of the day).

Insights & Suggestions of professionals:

- Doubts of the professionals: Although it was explained, the facial recognition system it is not clear how, from a lamp, the system can recognize the persons face and understand its mood.
- What about if the System learn (collect information) about Ana's interests (knowing she likes certain types of music, movies, theater), or the activities that relaxes her because is she previously shared it with the system. This can be used for her benefit.
- The idea of calling friends seems great but it is true that there are days that are not even to call friends.
- Will be interesting if CAPTAIN gives the possibility to detect factors that jointly may suggest a blood sugar crisis and recommend the performance of a new control (detection of tiredness/fatigue, change in balance, significant reduction of activity in a moment of the day when it is not usual, etc.).
- The program can have a mailbox for doubts about the results of their daily analyzes that she can decide to share with her GP.

4. Fabio

- Advantages/likes: it is a good idea if it is considering the person preferences, but she questioned how it could be possible, once normally you need to pay for having access. The Relaxing and Good Times saved material is something appreciated and useful feature. The remembering feature for key objects when going outdoor can be ok for whom needs it, but sometimes it is more difficult to find the objects than to remember what need to be in your pocket when going out.
- Requirements: consider the person needs in terms of visual impairments (size of projection, adapting size depending on the original size of the news that can be different from one website to other) once brightness affects normally elderly people and has is happening to her she is very sensible due to previous surgery to eye cataracts. Personally, she do not like the idea to have other person being warned about her daily decisions if she do not want to. The system may ask if it is ok to share it.

Insights & Suggestions of professionals:

- Deepen the customization feature (in one day may prefer one and other different journal or search by topics in other).

- Dynamic exercises including dual-tasking performance (physical and cognitive). These exercises could be agreed with the therapist for the days in which they are not working in the formal therapy.
- Training orientation during the exergames in order to help the person to Get Prepared. For example through "How to Get There" (maps) should be considered in the design process and softly integrated in other features, as something to have the possibility to choose but not overwhelming.
- Motivational narrative by the Coach may consider the weather: "Outside is a splendid day. Do you want to go out for a walk?"
- Relax feature: the idea of introducing the possibility to regulate environment/screen parameters, such as lights, colors, music, positive images, is welcomed by professionals and mentioned before in the Stakeholders Group, as a medium to promote positive attitude and encourage action towards social interaction.
- Proposed dynamic experience with 360º scenarios of nature (projected in the wall as the exergames) including audios guiding for some mindfulness exercises such as "body scan", "scanning of the environment", and "conscious breathing". The time, intensity, number of stimuli, complexity of the instructions may be graduated, among other variables, adjusting the selection of the activity and of the auditory guide (with audio tracks categorized in the system for an adequate recognition of parameters).
- Good Times: Having a handy continuously updated archive of good moments is something that promote a positive attitude and stimulate to action. Surprising as a powerful medium to help remembering. Surprising and emotional situations as a powerful medium to help remembering.
- Remembering objects to picked up: the information to be presented (images, pictograms, etc), need to be flexible to be decided with the person once the usage given to the artefact depends on the associations made with objects, images, etc.

5. Sofia

- Advantages/likes: If it can generate a sense of improved confidence will be great, although she have some concerns regarding the warning signs around the obstacles, because she feels it can call too much attention and be a factor helping to cause a fall. If there are other more positive approach, it can be better. Because warnings can change for moments the house environment with negative signals.
- Highlighted relations: Possibly the instability problems and fears she have affects in great measure her social contacts and outdoors activity.
- Requirements: Focus on supporting social life is very important in all cases.

Insights & Suggestions of professionals:

- Receiving news from local activities and events related to the person interests is a great motivation to participate. The possibility to choose is something that cultivates sense of independence.
- Balance exercises the person can perform gradually (and with automatic "regulation" of difficulty levels) to regain confidence and balance. Does the system have the possibility to detect similar parameters to those collected by the wii balance board?
- The ideal is that the house should have the minimum possible of obstacles, because if Captain is continually telling her aspects through which she can improve indoor safety.

6. Dimitris

- Advantages/likes: Interesting the cooperative games for those that are alone and have difficulties going out or receiving friends, but in her perspective this do not substitute the real presence and do not understand how the interaction can be fun and endow her with a feeling of pleasure. If it will be so easy to use, not requiring specific training, it will favor the social contact

of many people, being able to improve quantity or even quality. Importance of having the possibility to choose which aid functions to have or not.

- Requirements: consider that the cooperative activities can be a complement but the system need to motivate especially for other kind of activities with higher sense of presence, otherwise we can fall in the error or feeding that feelings of loneliness and depression. When the person do not want to go out and do not accept any other suggestion can be good to have this form of contact.

Insights & Suggestions of professionals:

- In addition to the presented approach, which seems fine, CAPTAIN may present to Dimitri the cultural and / or sports activities that are in his city that week, in case he is encouraged to attend any of them. Some talk, workshop, always taking into account their hobbies and tastes. Captain can also encourage him if he is autonomous to go to do outdoor exercises, for example, swimming pool, or walking in the park... something that helps to maintain the social activities that Dimitri can do.
- Considered Priority features in this case: Call People (Family & Friends), Receive Invitation to Activities & Places (Favourite & Daily Ones - Let's try something new - What I can do for others), Good Times archive.
- Call People: relatives are the first social safe surrounding of almost all the people with MCI and they are also the first elderly would like to keep in touch with; their invitations represent also the principal motivation to leave the house/explore to new places. Importance of relatives as a motivation/inspiration to interact, go somewhere, do something.
- Social opportunities & Invitations: Invitations to activities/events/places should come to the person attention, more than wait for him/her to invite. To work well that feature needs a substantial participation/collaboration of relatives/professionals/carers, as well as a good matching of data done by CAPTAIN between the person attitudes/preferences and activities/events/places scheduled in the neighborhood.
- Motivate/inspiring carers, relatives and friends to interact with the person, opening new ways for it (funny, enjoyable, simple ways): In that sense, the system also need to support and motivate relatives or close friends to interact and to prepare motivational resources, playing or sharing (e.g. videos or audios to be used in specific situations when the person can show some apathy, depressive mood, or even resistance to perform some recommended activity that is key for the person wellbeing). CAPTAIN can ask his son if he would like to live him a morning message (yes, no, possibility to delay the activity sometime) making that kind of interactions so easy and helping to create a routine of improved social interactions. It can also offer a simple training module of "motivational communication" (it can be a 2 minutes interactive video with some interesting tips to help to generate confidence).
- Activities deeply linked with preferences and interests have more chance to be chosen and produce an effective improvement of daily life and positive attitude. On the other hand, a good way to discover/try new things and meet new people is by proposing activities to a consolidated group of friends, so they can do that together with new persons.

11 ANNEX 5: END USER CONSULTATION FROM APSS

Procedure: A facilitator provided a powerpoint presentation of the case studies created for the project to 2 caregivers. Other facilitators took notes of the suggestions brought forth by the caregivers (the

Scientific Responsible for the project was also present). The presentation was provided to both caregivers at the same time, and the discussion facilitated with both caregivers contemporarily.

Both caregivers (from here on in referred to as CG1 and CG2 – professionals who work at Villa Rosa Hospital) assist their mothers (both in the advanced age of >83 anni) with memory impairments, but CG1's mother (who lives with a son who works during the day) demonstrates more advanced cognitive disturbances. The principal difficulty of both caregivers' mothers is memory problems. They need to be reminded to perform certain important daily activities as well their sequence. CG1 emphasized that her mother has a strong personality and is authoritarian, and thus suggestions provided to her must not damage her self-confidence otherwise her mother will not accept suggestions and even less the technology

The presentation and subsequent discussion lasted approximately one hour.

General comments applicable to all case studies presented

After the general introduction of Captain, (but prior to the description of the specific case studies), CG1 and CG2 asked if the technology is able to take into consideration the scarce compliance by older individuals with digital systems: they were reassured from the facilitator that the system is intelligent and that the elderly person does not have to configure the system him/herself.

In addition, both caregivers asked if the system is configurable (by the clinician/caregiver) based on specific needs: this utility is of paramount importance.

One of the caregivers stated (and the second subsequently agreed) that the introduction of this type of assistive technology such as Captain has sense in an initial stage of cognitive impairment, so that it can be accepted by the individual (in an advanced state it would be just a hindrance). They emphasized the need to "prepare" the elderly person to the introduction of these types of support.

Comments referred to specific case studies

1. Carlos

It is noted that a walker is not an instrument that allows to emulate a long walk in an outdoor environment: more helpful (compatible with the mobility of the individual) would be an exercise bike.

Alternatively, it is suggested to project a virtual trainer that explains how to correctly perform upper extremity exercises. Both caregivers state that their parent would not appreciate the photograph with the virtual background (and themselves too would find it unuseful).

2. Maria

CG1 stated that her mother (who likes to cook) forgets the different types of ingredients and adds the wrong things and thus the case study is relevant. She suggests that it may be annoying if the individual has to inform Captain that he/she has added an ingredient: Captain should instead monitor the process, become aware of oversights and ask the elderly person confirmation of having added a certain ingredient.

Both caregivers state that for their mothers it is not realistic for them to sit on the couch calmly performing cognitive esercises while dinner is being cooked: they feel it is important that an elderly person perform one activity at a time.

Regarding the cognitive exercises: they are not useful for CG1's mother (as she constantly moves around), while CG2 feels that the exercises would have to be particularly interesting

3. Hannah

This case study if particularly useful for CG2's mother (who needs to remember to take her medication)

It is suggested that Captain should be able to independently alert the doctor if there are parameters significantly out of range (if for example a predetermined threshold is passed or in the case that there is a deviation from the normal trend)

4. Fabio

CG1 states that the reading of a newspaper projected on the wall could be uncomfortable (because of the vertical projection- the visual field is more easily explored horizontally instead of vertically – but also for the size of the words): a monitor/television would be more appropriate. The projections with icons that do not require an intense visual strain are instead appropriate (for example: the weather conditions).

With regard to the notifications to family members in the case of the elderly person leaving home, a notification advising every time they leave home could be excessive: it may be more useful to notify only when the exits from home are a deviation from a normal routine).

For CG2 the type of notifications useful for the elderly person are typically "did you turn off the gas?" – turned off all the electrical devices?"

5. Sofia

Nothing in particular noted, a case study realistic and useful