affec**T**ive bas**E**d i**N**tegrate**D** car**E** for bette**R Quality of Life (TeNDER)**

D2.3 - First version of TeNDER Architecture Blueprint, Pilots definition

Work Package WP02

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The TeNDER consortium consists of the following Partners:

Table 1 TeNDER Consortium List

No	Name	Short name	Country
1	UNIVERSIDAD POLITECNICA DE MADRID	UPM	Spain
2	MAGGIOLI SPA	MAG	Italy
3	DATAWIZARD SRL	DW	Italy
4	UBIWHERE LDA	UBIWHERE	Portugal
5	ELGOLINE DOO	ELGOLINE	Slovenia
6	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS	CERTH	Greece
7	VRIJE UNIVERSITEIT BRUSSEL	VUB	Belgium
8	FEDERATION EUROPEENNE DES HOPITAUX ET DES SOINS DE SANTE	HOPE	Belgium
9	SERVICIO MADRILEÑO DE SALUD	SERMAS	Spain
10	SCHON KLINIK BAD AIBLING SE & CO KG	SKBA	Germany
11	UNIVERSITA DEGLI STUDI DI ROMA TOR VERGATA	UNITOV	Italy
12	SLOVENSKO ZDRUZENJE ZA POMOC PRI DEMENCI - SPOMINCICA ALZHEIMER SLOVENIJA	SPO	Slovenia
13	ASOCIACION PARKINSON MADRID	APM	Spain

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[1] **R:** Document, report; **DEM:** Demonstrator, pilot, prototype; **DEC:** Websites, patent fillings, videos, etc.; **OTHER**; ETHICS: Ethics requirement; ORDP: Open Research Data Pilot.

[2] **PU:** Public; **CO:** Confidential, only for members of the consortium (including the Commission Services).

Document History

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V25	6/10/2020	Draft	SPO	Insert chapter 3: User

				Stories with inputs to AD home and day care centres, general comment
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V28	13/10/2020	Draft	MAG	Review and inputs on arch next steps
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V36	27/10/2020	Draft	Cristina (SERMAS)	General review
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Acronyms and Abbreviations

Acronym	Description
TeNDER	affecTive basEd iNtegrateD carE for betteR Quality of Life
WPx	Work Package
Tx.x	Task
Mx	Month (where x defines a project month e.g. M8)
EU	European Union
IoT	Internet of Things
IoHT	Internet of Healthcare Things
GP	General practitioner, primary care physician
QoL	Quality of Life
Pwd	Person with dementia
AD	Alzheimer's Disease
PD	Parkinson's Disease
CVD	Cardiovascular Disease
WHO	World Health Organization
NGOs	Non-governmental organizations
EHR	Electronic Health Records

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Executive Summary

TeNDER is a multi-sectoral project funded by Horizon 2020, the EU Framework Programme for Research and Innovation, developing an integrated care model to manage multi-morbidity in patients with neurodegenerative diseases and for cardiovascular patients. TeNDER is developing an integrated care ecosystem for assisting people with Alzheimer's, Parkinson's, and cardiovascular chronic patients, facing comorbidities, using affect based micro tools, communication, monitoring of the patients with their care ecosystem (involving their caregivers and socio-healthcare professionals). These micro tools will be able to adapt to the needs of each person and thus adapt the system's probes to the person's situation via a multi-sensorial system, even in the most severe cases, and match with clinical (from Electronic Health Records EHRs) and clerical patient information, while preserving privacy, monitoring the ethical principles, providing data protection and security, with the result of an increased quality of life.

To achieve this general goal, TeNDER will perform 5 large-scale pilots to test services targeting patients, their caregivers, social and health care professionals. At each pilot setting (in Slovenia, Italy, Germany and 2 in Spain), patients will be monitored according to the use cases and scenarios defined. TeNDER's technical, legal, and ethical experts ensure that all personal data is protected according the General Data Protection Regulation (GDPR).

 We intend to assess real-world living environments of patients as broadly as possible and define scenarios for project pilots. Scenarios will be framed in requirements and constrains of ethics, privacy as well as necessity of creating the navigation and draft plans for the components of TeNDER toolbox. Services created with this approach will create opportunities for facilitating communication between social and health care professionals, extending the autonomy of patients that will live more independently. This deliverable continues the common research framework advanced in D2.1 and D2.2, also building from the results of the requirements previously identified and tested with real end-users. This document details the pilots' definition, connecting end-user's organizations with technical partners, through CERTH's contribution to the Architecture Blueprint, also based on the requirements and needs gathered through research over the first year of its implementation. TeNDER is in the process of development using a co-creation methodology approach through common TeNDER toolbox. This document connects User requirements, Scenarios and System Requirements.

TeNDER brings together the experience of previous European projects (e.g. ICT4Life[3], PATHWay[4], iPROGNOSIS[5] and others) in integrated care, health monitoring and disease prevention to build and fully test a large-scale system, capable of providing tailor-made integrated care services to promote well-being and health recovery for three major diseases, namely Parkinson's, Alzheimer's, and cardiovascular diseases. TeNDER is seeking a concrete measure for a change in the quality of life of people using the TeNDER system by employing professional for **pre- and post-test** quality of life assessment, involving different stakeholders in care, ranging from caregivers, social workers, patients, doctors, general practitioners (GPs).

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[3] ICT4LIFE UPM DSS Repository- https://gitlab.com/davidGATV/ict4life-decision-support-tool

[4] https://cordis.europa.eu/project/id/643491

[5] https://cordis.europa.eu/project/id/690494

TeNDER will span 36 months, following an iterative and incremental methodology inspired by Agile methods (e.g. SCRUM) adapted to H2020 projects and already successfully adopted in projects led by TeNDER partners (e.g. UPM, CERTH):

● Implement a user-centric design process involving end-users, including all the relevant stakeholder as well as the Advisory Boards, in a systematic manner during the entire project.

● Promote early, iterative, and incremental integration of components as well as regular validation and revisions of the project results, and activities, to avoid deviations from the objectives and the user needs.

Introduction

The TeNDER project is creating an integrated and personalized ecosystem to assist people with chronic diseases such as Alzheimer's disease, Parkinson's disease, and cardiovascular disease, facing comorbidities, by providing them with micro services that have the objective of improving their quality of life. To assure the adequate alignment of WP2, WP6 and WP7, deliverables 2.3, 6.1 and 7.1 are being discussed in parallel, integrating to all the relevant consortium members in crossed discussions on requirements, pilots' definition and QoL research tools.

This deliverable presents in the first place the Architecture Blueprint developed by the technical partners led by CERTH and UPM. The following sections further develop to provide a country specific profile analysis of integrated health care and general description of TeNDER ecosystem, focusing on questionnaires items, adequate methodology and development of template for performing the analysis of service provision flows, to be administered to patients, socio-healthcare professionals, and caregivers. KPI measurement and compliance has also been considered when defining the research tools, to properly identify the baseline and its evolution over time by citizens using TeNDER.

The final outcome of the work in this task is a specification of user needs, user requirements and user scenarios that will guide the design of the TeNDER system requirements. It involves the dedicated contribution from end-user entities and medical bodies in TeNDER to analyse the available technologies, as well as to further collect needs and requirements of each specific category of end-users in terms of services solution characteristics, interface, and contents, as well as current fields of interaction among the involved actors: socio-healthcare professionals, caregivers and associations, local authorities in the pilot countries. State of the art literature will be analysed, compiled, and reported to illustrate and align the needs and constrains for users in the categories defined. The output of this task will be a complete system vision incorporating needs of all actors as well as supported by the medical and social evidence.

1. TeNDER common approach and methodology

The aim of the project is to improve the quality of life of patients and those around them, including caregivers and socio-healthcare professionals through the TeNDER tool based on different technological devices. Firstly, it is intended that the TeNDER integrated care model is suitable for monitoring patients with the aim of improving their autonomy and facilitating the task of caregivers and professionals in their care and monitoring. Secondly, it aims to facilitate communication between all the actors involved. Facilitating the intercommunication of patients and caregivers with social and health care professionals, especially in those cases where professional care and monitoring is required.

All this is proposed by combining technologies that are easy to use and known by the population, such as intelligent mobiles (smartphones) and devices, like, bracelets, motion sensors, and other similar tools through which vital signs are monitored, movements are captured, and emotional recognition is carried out among other types of monitoring.

1.1 Ethical and legal compliance

As the TeNDER project intends to conduct large scale pilots with human participants, the principles of medical ethics are significant, including the principle of autonomy, beneficence and non-maleficence and justice. These principles should guide TeNDER partners when conducting the pilots[6]. Some key findings:

- *As the TeNDER project intends to engage potentially vulnerable groups (older persons, persons with chronic illness, including neurodegenerative diseases, and those unable to give informed consent), it is important to note that the TeNDER project is in line with international norms which provide that medical research with vulnerable groups should be responsive to the particular needs of that group and that it cannot be carried out in a non-vulnerable group.*

- *The TeNDER project will put in place specific safeguards and protections to minimise the risk for these vulnerable groups, as advised by the same international norms.*

- *Of relevance is the notion of informed consent, a cornerstone of the principle of autonomy, which should be obtained from all research participants. Such consent should be given freely, specific, informed and a reflection of the participant's wishes.*

Procedures for obtaining consent in TeNDER

For TeNDER pilot-partners, one of the initial steps in the informed consent procedure will be to assess and determine whether the potential participant has capacity to consent, or whether consent from their legal representative will need to be sought[7].

For those potential participants determined to be able to give consent, and considering those considerations set out in above, the relevant pilot-partners will ensure that the following additional steps are taking in connection to the process of obtaining informed consent:

- Comprehensive information is provided to the potential participants to enable them to make an informed decision about their participation. This information is accompanied by a consent form, including relevant references to national and local legislation, which will document the confirmation of consent;

- The consent form will include the necessary information related to the processing of personal data of the participants in compliance with EU, national and local legislation;

- Ensure that the information provided to each potential participant is adapted to their needs, especially in connection to vulnerable groups.

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[6] Article 34(1) (Ethics and Research Integrity), GA.
[7] Official Journal of the European Union- DIRECTIVE 2011/24/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 March 2011.

1.2. TeNDER approach

TeNDER is developed in two parts:

1. The first part (Phase 1) studies on the end-users (patients, caregivers, and professionals) the requirements, usability, and acceptance of the technology, through interviews and questionnaires to the three population profiles. The aim is to develop a technological tool adapted to their preferences and needs.

2. The second part (Phase 2, 3 & 4) are the five pilots. This intended to be a large-scale intervention phase to be carried out in a total of 5 institutions in different countries. During this pilot phase, feedback will be received from users on the tool to incorporate the modifications and improvements detected. With this, it is intended to develop a collaborative work with the beneficiaries of the tool.

Phase 1 Requirement gathering and assesment (M1-12)

M1-M6. **First version requirements** based on authority sources

M7-M12: **Validation** with end users of requirements through interviews and surveys.

- Survey Requirements (patients, caregivers/carers and professionals)

- Interviews Requirements (patients, caregivers/carers and professionals)

Phase 2,3, and 4 Pilots' Implementation (M15-M30)

- **3 Waves** (First, Second and Third wave)

Figure 1 TeNDER phases

The co-creation process in TeNDER project will contribute to the definition of the relevant functionalities with devices/sensor equipment sets for different environments - Pilots. We will use surveys and interviews for the creation of Personas and scenarios. During the piloting phase end-users will be involved in the co-creation process with the use of defined tools. The main purpose of the later step will be to assess the piloted scenarios and provide feedback for the technical development of the TeNDER solution.

The main tools used in survey and interviews will be questionnaires. The protocol requires the recruitment of patients affected by AD, PD, CVD, heterogeneously represented by gender, with an age of ≥60 years. Main demographic and personal variables for Persona definition will be:

- Stage of the disease (mild/moderate/severe);

- Type of the disease (AD/PD/CVD);

- Areas of living (rural/urban, hospital/day care centre/home);

- Gender (male/female);

- Age.

Different scenarios, using similar sensor will be used at four different living setups:

- Home;

- Day Care Centre;

- Hospital;

- Rehabilitation Room.

TeNDER's end-user organizations have agreed on a common research approach, including ethical considerations and interaction protocols for researchers to ensure comparability of data across countries, diseases, and end-user profiles. All relevant research tools have been integrated into a common document, the Research Book. Procedures have also been established for analyse.

The information collected through research, which are provided for in the monthly reports of the end-user organizations, including the information coded in the common template for regular data analysis. This knowledge will be shared with technical partners to assess the feedback from the iterative testing of the technology.

Research tools include:

- Informed consent form template for participation in research and processing of personal data.

- User Requirements Questionnaires and Interviews.

- Standardized questionnaires for QoL (SF36).

- Tender User Experience Questionnaire.

- Satisfactions questionnaires and interviews.

- Usability questionnaire and interviews.

This complex socio health approach, together with the high numbers of the pilots to be developed, will offer strong grounds for sound inferences based on the gathered and analysed information.

1.3. Data workflow

The picture below describes the data flow of TeNDER ecosystem and its various modules, namely: Low-level-subsystem, the High-level-subsystem, and the related Services.

It is necessary to specify that all the sensitive data collected is stored and processed locally, while general information (metadata) is sent to the cloud where it is processed in the high-level secure layer subsystem which mostly implies the adoption of protocols for communication over the Internet that protects the integrity and confidentiality of data exchanged between computers and sites, such as HTTPS (Hypertext Transfer Protocol Secure) and the implementation of RabbitMQ, i.e. message-oriented middleware, also known as messaging broker implementing the Advanced Message Queuing Protocol (AMQP) for the integration of real-time data from detection devices.
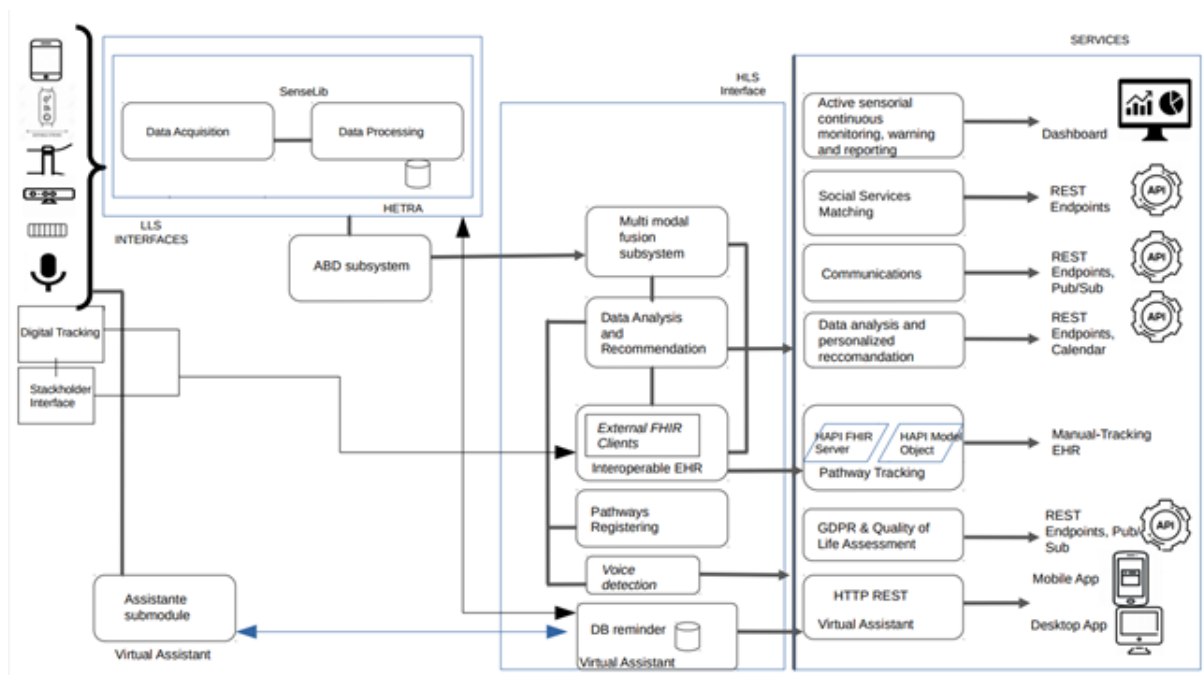

Figure 2 TeNDER Dataflow

Regarding the input for data flow, the following sets are considered:

- Data detected through selected devices (such as Camera, Wristband, Position Tracker, Sleep Tracker, Voice Tracker, Pill Dispenser, binary sensors) that considers different types of data, represented by a JSON file or file wave;

- Digital Tracking: monitoring user interaction on the app with timestamps and driving the recommendation system. These interactions are worked in the backend and fed to the recommendation system;

- Stakeholder Interface: Stakeholder Interface collects external data about patients contained in spreadsheets, information systems, databases, or questionnaires. The data to be shared are linked to their health status and quality of life assessment together with geolocation data for mood detection, activities tracking and pathway gathering. The management of this data takes place in the EHR module in the High-Level Subsystem.

Data Flow in the Low-level Subsystem:

In the low-level layer data are acquisition and processed and analysed to be extract the characteristics, useful for subsequent analysis.

- Data acquisition process: as described in section 4.2, SenseLib subsystem is responsible for the data acquisition, allowing to track patient variables and providing to the modules of the low- and high-level subsystem the functionality to track specific health characteristics, from direct information on the health situation to the results of periodic tests and feedback from professionals;

- Data processing: SenseLib is not only providing the raw data acquired by the sensors, but is also analysing them to extract the characteristics that will be useful for subsequent analysis of Abnormal Behaviour Detection (ABD) module and HLS subsystem;

- Data summarisation and Data cleansing: This process is carried out by the Abnormal Behaviour Detection module, module in charge of summarising and categorising real-time events by querying local databases that collect data from each scenario decreed. The information collected from DB which is useful for summarising processes are: daily motion, quality of sleep; bio-measures; freezing, festination, leaving the house; medication intake. Instead the summarized files. From ABD module are in JSON format and containing: number of events, Beginning, End: Number of times. data cleaning process: when all the data is extracted and summarized, ABD module will perform moreover a data cleaning.

See sections 4.2 and 4.2.1 for more details on the modules concerning LLS.

Data Flow in the High-Level Subsystem: the information arrives at the high-level subsystems both via: secure HTTPS connections and RabbitMQ queues. Therefore, in the High-level subsystem processed data coming from the ABD module has already been pre-processed by low level subsystem. Then, the flow in High-Level Subsystem, is as follows:

- Multimodal Fusion Subsystem receives information from the ABD subsystem and provides information regarding the behaviour of patients, their emotional status. It works by utilising deep Learning techniques, aiming to foresee inputs to the Data Analytics Recommendation, Pathway registering and the Electronic Health Record modules;

- Data Analysis and Data Recommendation are the principal modules from the HLS subsystems that continuously analyse information residing in external repositories related to historical data; patient profile and interaction via interfaces and Pathway registry. Their focus is the customisation of services and their functionalities;

- The Electronic Health Record (EHR) module is in charge of gathering in a dedicated database all the information about the patients (medical records), their activities, the interactions with doctors and caregivers and all related medical treatments, just to name a few. Therefore, this module manages and organises patient information, using HL7's Fast Healthcare Interoperability Resources (FHIR), a standard and accredited protocol specification, to manage the exchange of information on clinical and administrative health data.

An instance of HAPI FHIR Server was used for healthcare interoperability in Java. The HAPI Server's implementation of the FHIR standard provides an HTTP API to perform CRUD operation (create, read, update, and delete) on the database, supporting different deployment schemes and relational databases.

For the TeNDER ecosystem, there are different clients foreseen to be configured because of different are the formats of data sources to be gathered. Moreover, data to be collected not only contains private data, but it also reflects sensitive data, so explicit consent should be provided by patients and caregivers when submitting information to the platform. Based on these assumption three components are proposed for data collection:

- HAPI FHIR Client(s) – for EHRs collection from the pilots;

- CKAN – for the collection and processing of files from the pilots;

- RabbitMQ – for the integration of real-time data from sensing devices**.**

For further details we refer to the next section, while here below we report a figure about l Draft architecture for information gathering
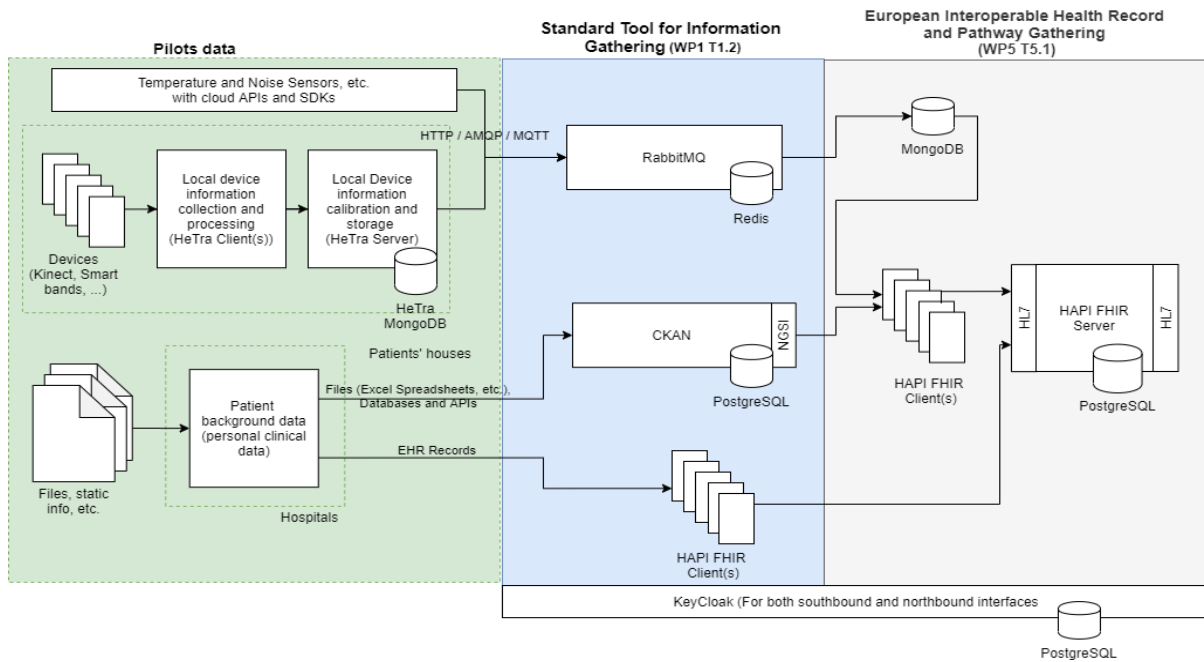
Figure 3 Draft architecture for information gathering

- **Pathways Registering: This** module aims to support healthcare professionals accessing information regarding the patient's health record. This subsystem tracks historical data related to patients' visits to doctors and hospitals and collaborates with the Low-level Subsystems to collect information about patient status and indoor movement patterns and trajectories.

- **Virtual Assistant:** This module is composed of two sub-modules developed in python that are executed in two docker locales on the pc box, present in the scenario, namely "Voice detection module" and "Assistant module." Voice Detection sub-Module receives in input the audio stream in real-time from the microphone and performs a recognition through a deep learning algorithm using a pre-trained model of predetermined sounds (crying, laughter, falling). Then, the module saves an output JSON file in a folder of the PC box with. The db-reminder provides vocal recommendations to the patient through the speaker. The module queries the DB at regular intervals to determine the presence of new reminders, then schedules an event at set times and, with the text to speech functionality, formulates and synthesizes the phrase that will be played through the speaker connected to the PC box. Moreover, the voice detection is linked to the recommendation module to provide vocal recommendation as well as to the Pathway Registering module tracking events on the patient.

Figure 4. 5 Virtual assistant System Architecture

Data Flow in Services Layers: The suite of TeNDER services work by using all the information generated through API Rest from LLS and HLS TeNDER ecosystem and headed by the central decision system (Data Analysis e Data Recom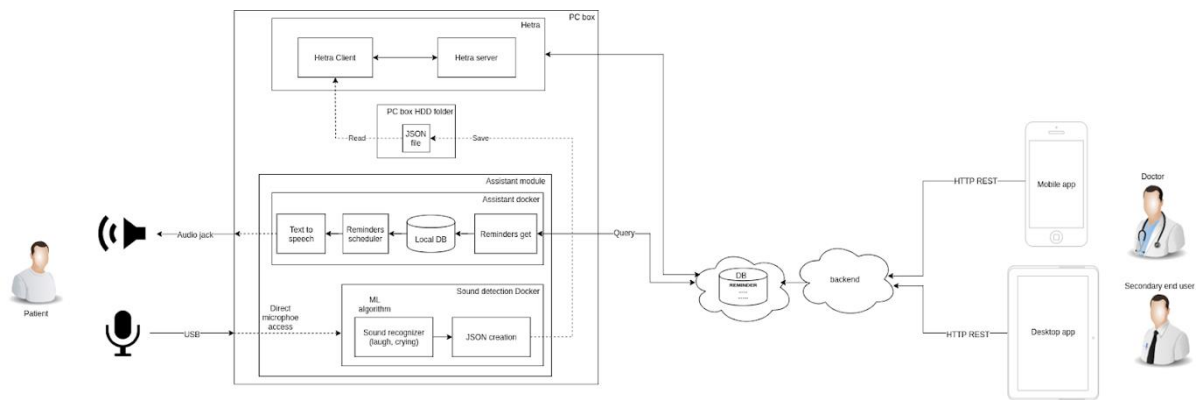mendation module), to ensure services provision. For the data processed between remote sensors and computers. It is foreseen a secure API they are connected to a central server (TeNDER cloud). All the services are provided to the users by means an accessible and dedicated platform and Mobile APP, with dedicated user interfaces. All the user's requests will have a valid token previously generated by login services.

1.4. Standards tool for information gathering

Deliverable D1.2 reports on a standard tool for information gathering, based on open standards and reference architectures that support data collection from multiple sources into the Electronic Health Record (EHR) from WP5. Taking into consideration the different information sources to be collected and their diverse formats, the team defined three components for data collection:

- HAPI FHIR Client(s) – for EHRs collection from the pilots.

- CKAN – for the collection and processing of files from the pilots.

- RabbitMQ – for the integration of real-time data from sensing devices

According to CKAN's official documentation[8], CKAN is a tool for making open data websites, helping users to manage and publish collections of data, which is used by national and local governments, research institutions, and other organisations who collect a lot of data. With CKAN, once the data is published, users can use its faceted search features to browse and find the data they need, and preview it using maps, graphs, and tables - whether they are developers, journalists, researchers, NGOs, or citizens. In CKAN, data is published in units called "datasets," a parcel of data. Examples could be the health records for a hospital, the quality of life survey responses by caregivers, or

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[8] CKAN official documentation – https://docs.ckan.org

temperature readings from weather stations. When users search for data, the results they see are individual datasets, each containing two things:

- Information or "metadata" about the data. For example, the title and publisher, date, what formats it is available in, what license it is released under, etc.
- Several "resources," which hold the data itself.
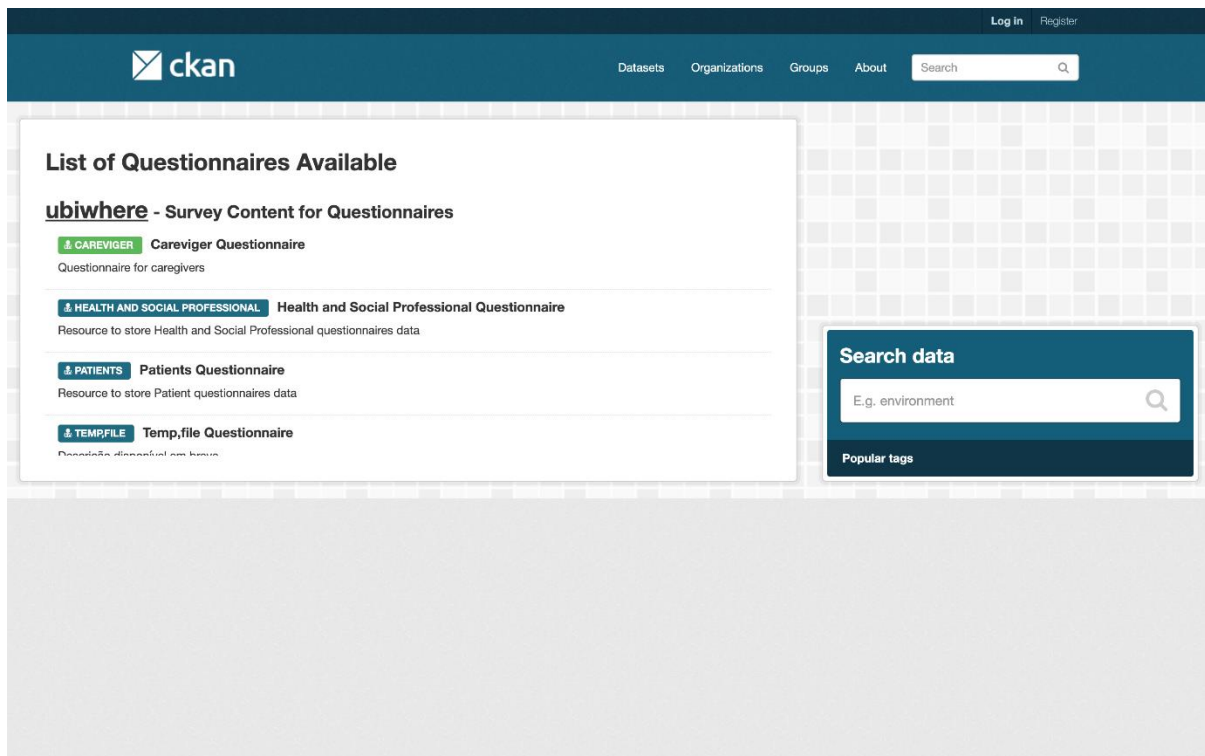
Figure 5 CKAN Screenshot for TeNDER data collection

CKAN does not mind what format the data is in. A resource can be a Comma Separated Value (CSV) or Excel spreadsheet, XML file, PDF document, image file, linked data in RDF format, etc. CKAN can store the resource internally, or store it simply as a link, the resource itself being elsewhere on the web. A dataset can contain any number of resources. For example, different resources might contain the data for different years, or they might contain the same data in different formats. This tool provides pilot partners with a user-friendly means to share information in an organised manner, as seen in the following images, collected from CKAN's website[9].

An extension for CKAN was developed to support the Questionnaire rendering and response collection that allows users to create and fill multiple questionnaires. CKAN will be used as a data collection tool for end users and will allow them to create a data set and store data of interest from:

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[9] CKAN User Guide – https://docs.ckan.org/en/2.8/user-guide.html

- Tender User Experience Questionnaire.

- Satisfaction questionnaires and interviews.

- Usability questionnaire and interviews.

Each dataset is owned by an "organisation" within CKAN, which can manage any number of organisations. In CKAN, each organisation must have a person responsible for its data security (described in W10) and can have its own workflow and authorisations. These administrators can add individual users to the organisation, with different roles, depending on the level of data access authorisation needed. The users of a given organisation can create a dataset owned by that organisation. In the default setup, these datasets are initially private, and visible only to other users in the same organisation. When it is ready for publication (i.e. sharing with other users and organisations), it can be easily done via the user interface, although it may require a higher authorisation level within the organisation. With this setup of organisations and datasets in CKAN, it allows the responsible managers of a given institution to provide / collect information from their end-users in a secure manner.

Considering that one of the many ways to collect information in TeNDER to evaluate the status and quality of life of patients and their caregivers is by filling out questionnaires, CKAN was adapted with an extension that renders a questionnaire in a web view (for data collection) and stores its responses as a dataset resource of a giver organization. CKAN was thus adapted to consider an extra pair of key/values when creating a new dataset, to concisely define its specific purpose. For now, it supports three types of keys:

- **is_data_store**: with the purpose of defining a dataset as a data store from the questionnaire's responses (i.e. this dataset will contain the survey responses and updates it every time someone fills in a questionnaire);

- **is_patient_store**: to define a dataset as a data store from the uploaded patients' files (i.e. the uploaded files will be processed via RabbitMQ consumers and stored into the HAPI FHIR's EHR);

- **is_templating**: with the purpose of defining a dataset as a survey content store (i.e. this dataset will contain the survey structure and questions in a JSON format).

This extension was tested and can be executed for version 2.8 of CKAN. Below a few screenshots of the surveys are presented:

Figure 6 Example of the SF-36 questionnaire definition in TeNDER CKAN collection interface

Figure 7. Example screenshot of TeNDER questionnaires

All the responses are stored in CKAN as a dataset resource (cf. image below).

_id	id	→info	date_submitted	tender_user_experience_1_question	tender_...
1	health_and_social_professional	health_and_social_professional_quest	2020-09-18T17:30:55.702Z	How would you rate your working conditions with TeNDER?	excellent

Figure 8 Example of a health form registered in the dataset resource

Datasets can be marked as public or private: the public ones are visible to everyone who can access the CKAN instance, and the private datasets can only be seen by logged-in users who are members of the dataset's organisation. Private datasets are not shown in general dataset searches but are shown in searches within the organisation. Datasets cannot normally be created except within organisations despite being possible to set up CKAN to allow datasets not owned by any organisation that can be edited by any logged-in user.

2. Real-world scenarios and use cases

2.1 TeNDER User Stories

What is a User Story?

User stories are a technique coming from the Agile methodology, used to describe the requirements of a digital solution, like an App or software etc. from a user perspective (in contrast with product-based requirement documents). The user stories detail all the elements and interactions that enable the envisioned user experience with a mobile app, website software, and connect the work of the design team (developing interaction flows and UI components) with the process of back-end and front-end development, enabling a better integrated workflow in sprints (rather than a water-fall development process).

What are User Stories for?

User Stories are a great way to clearly define the role a product/service play. A set of well written and prioritized user stories can certainly help the team to express and share the functionality of the product without going into technical details.

A. User stories for Alzheimer's disease and other forms of dementia

A   Home set scenario

Use Case 1

John is a 68-year-old who lives alone in his house. Recently, he has been diagnosed with an early stage of dementia. His family lives separately and is visiting him once per week. He is regularly engaged in sport activities, but lately he skips his exercises. When asked why, he says that it is not the right day to go. His family has noticed that he lost interest to go out with his friends during last two months. He has also forgotten about his nephew's 10th birthday (that he never did before, as he was very punctuate about all the birthdays in the family). Lately, he is often in a bad mood and does not want to talk on the phone.

As before, he called first and was likely to initiate the conversation, but now he speaks in a few words when he is called and finishes the call suddenly. Lately, when he talks, he is always worrying about several things. Some days he gets angry and ends the call suddenly. He also panics about what he sees on the TV. His family is concerned, because he is still active and independent man and continues to do his daily chores (shopping, walking, going to activities) and sometimes does not give notice that he is leaving home. His family is worried that he might become disoriented and not know how to return home on one of his outings. They have also noticed that John has left the house door opened for several times when they came to visit and he was outdoors.

He started to leave lights on in the house when he goes out and does not care if garbage is not taken. His relatives would like John to continue to be autonomous, to be engaged in activities and social active, to be safer and to be able to detect if he leaves his usual walking area and if so, to be able to find him easily.

In this scenario, the sensory equipment should be able to detect the primary user's movements and location inside the house, to give alert if the doors will be left opened, to provide personal calendar to remind patient of his activities and important dates, and to detect if he leaves the house. The functionality of mood detection could also be provided. The family could access the data if primary user allows it. The professionals could also access the data to adapt and personalize the approach to the patient. For this purpose, a real-time localization will be implemented. The patient will be equipped with a light commercial bracelet and a Bluetooth scanner will be installed in the living environment. Caregivers will be notified if the bracelet is removed. The Bluetooth scanner is a small, unnoticeable device that monitors the signal strength of the bracelet and estimates the user's position. The Bluetooth scanner will also be connected to local Wi-Fi through local routers locally to an attached storage and send data/reports to the cloud only when critical events occur.

Notifications and alerts will be sent to the mobile devices of the caregivers and professionals involved. Participants will have the option to access the notification server through their personal mobile devices. A calendar can be implemented to plan important events.

Use case HOME 2

Maria is a 76-year-old and she lives with a daughter in their house. Recently, her daughter has reported, that Maria walks around the home a lot, often going in her (daughter`s) bedroom. Maria has starting to refuse to eat in the dining room. One day her daughter found Maria drinking coffee in a toilet room. Maria has angrily accused her daughter of stealing her belongings from her room several times last months. Maria is often complaining that her sleep is poor and that she wakes up at night several times. Then, Maria sometimes refuses to get out of bed all day. Maria sometimes likes to stay up late and annoys her daughter with preparing lunch at night time. Maria is often in a bad mood first thing in the morning, and shouts a lot.

The neighbours have reported, that when the daughter is at work, they have heard shouting and crying form the apartment. The daughter has asked Maria about this and if she has fallen, but Maria does not want to talk of this matter.

In this scenario, the sensory equipment should be able to detect the patient's wandering and location inside the house, to give alert if the doors will be unlocked, and to detect if he leaves the house. The pad can be put under the mattress, to track sleeping quality. The family could access the data if patient will allow for the safety purposes. The professionals could also access the data to adapt and personalize the approach to the patient. For this purpose, a real-time location will be implemented. The patient will be equipped with a light commercial bracelet and a Bluetooth scanner will be installed at the entrance of the house. The selected bracelet will have a long battery life (at least 10 days) and will be waterproof. It can be worn at all times without the need to remove it. Caregivers will be notified if the bracelet is removed. The Bluetooth scanner is a small, unnoticeable device that monitors the signal strength of the bracelet and estimates the user's position with a GPS system. The Bluetooth scanner will also be connected to local Wi-Fi through local routers locally to an attached storage and send data/reports to the cloud only when critical events occur.

Notifications and alerts will be sent to the mobile devices of the caregivers and professionals involved.

Use case 3

Marge is a 65-year-old and she lives with her daughter Nicol. Marge has started with an early stage of dementia. Marge has a lot of friends and attends several activities: yoga, body-balance, reading group, cooking group… Nicol noticed that Marge is skipping her activities and did not go out with her friends for more than once per week (that is different than before). Nicol noticed, that Marge has fallen immediately after getting up from the bed for a few times lately. Nicol makes sure her mother follows her medication prescription. However, she noticed that Marge is staring to complain that cannot remember all the things that a person is telling to her and becomes very agitated with conversations that last more than 15 minutes. She has also been found to stand still for long in one room and left things unfinished for several times during last month, and Nicol is worried that she fells disoriented in the house. Marge was included in activities of the library and was writing reviews of books she has red, but now she stopped and if asked, does not want to talk about it anymore. During the day Marge goes to a day care centre, requiring some coordination to assure that she keeps on taking her medication. Nicol would like to have reliable information on her mother's medication intake.

Using TeNDER Smart-Band, fall detection, mood detection, localization monitoring, electronic pill dispenser and app, Nicol, the doctor, and the day-care centre nurse are all coordinated and informed about Marge's adherence to treatment and the progress of the disease.

For this scenario, the patient can check his schedules and activities. The sensory equipment should be able to detect the patient's location inside the Centre (in the room or not) in case, he/she gets confused, moreover, it could be used on the backyard of the Centre. The nursing team should be able to detect when a patient is taking his/her medication incorrectly. The patient will get a smart pill dispenser, connected to the network, and assigned caregiver and/or health care professional will

be notified on the smartphone app or the WebApp if the medication was not taken out of the pill dispenser. Reminders will be sent to the patient to assure that the medication intake adjusts to the doctor's recommendations. The calendar with alerts can be set by the patient herself, authorized caregivers, and health personnel of the day care centre.

Notifications and alerts will be sent real time when critical events occur on the mobile devices of the caregivers and the day care centre nurses. Delayed reports will be forwarded on demand to health care professionals. Participants will have the option to access the notification server to check the accuracy of the system and to remind their medication patterns.

Required functionalities on mobile / PC devices for settings and notifications

Personal calendar screen

- User ID (after log-in)
- Main menu with the list of functionalities available: List of users (role), that have permission to review and / or modify the entries
- Simple calendar for entry, that can be used by primary and if given permission all involved in the care chain.
- Prepare user friendly alerts, showed in the app

Location and activity screen

- User ID (after log-in)
- List of users, that have permission to review and / or modify the entries
- Movement detection (list of rooms for setting up monitoring; notification if primary user is erratic, non-moving or fall)
- Prepare user friendly alerts, showed in the app

Perception of emotional state screen

- User ID (after log-in)
- List of users, that have permission to review the emotional state
- Graphical representation of emotion (maybe a banner in distinct colours, above the room's list of the primary user, for notifications)

EPIC	USER STORY (US)	Acceptance criteria
Type of user: **Primary:** User (Patient) **Secondary:** Caregivers (Family) Health Professionals **Homeset** **Modules:** TeNDER smartphone app.	**User: Patient** **Service: Registering and Logging** **Example 1:** As a user interesting in TeNDER, I can register in the APP, being able to see what the implications of it (previously informed) are as well as my rights and duties. The consent must be clear and easy to understand. **Example 2:** As a TeNDER user I want to be able to login to TeNDER app to securely access to my account. **Reason:** The information of the users will be	**As a user (patient) must be able (or be trained) to use TeNDER app.** The acceptance criteria are: is the patient able to login into the TeNDER app? **Exception**: The patient is not able to do it due to impairments and the

TeNDER multi-sensorial capturing module **Services:** **S1**: Active Sensorial Continuous Monitoring, Warning and Reporting **S3**: Data analysis & Personalized Recommendations **S5**: Virtual Assistance **S6**: Communication	protected and only authorised ones will access it. **Why?** as citizen I want to see my evolution (empowerment). **Example 3:** As a TeNDER user (registered & logged), I want to access all services available in the app. I want to quickly access services from there. The design shall be intuitive, and in accordance with my understanding/comprehension of technology. **Service: Data Access** As a TeNDER user (logged in) I should be able go to the services, having fast access to my personal data (in a personal data area). I want to be able to insert data, as well as remove data. As a user, I want to decide whether a health professional can see my data or not. As a user, I want to decide whether several health professionals can access my data or not As a user, I want to decide whether grant access to a physiotherapist or not As a user, I want to decide whether several physiotherapists can access my data or not As a user, I want to decide whether grant access to a social worker or not. As a user, I want to decide whether several social workers can access my data or not. As a user, I want to be able to decide whether I wish or not my data to be shared with the diverse roles. **Service: Health Tracking & Data Visualization** **Example 1** As a TeNDER user (logged in and subscribed to the health tracking using the sensorial system), I want to decide when I wish the TeNDER Multi-sensorial system to be disconnected. **Reason:** the final	caregiver or responsible must be able to do it. As a user (patient) or caregiver must be able (or be trained) to stop/start TeNDER sensor monitor system (if subscribed to health tracking). User comfortability with the system in terms of: **acceptance** and **performance**. As a user (professional) must be able (or be trained) to use TeNDER Desktop app for professionals. As a user (professional) must be able (or be trained) to create personalised rules for patients. Professional comfortability with the system in terms of: acceptance (easy to use) and performance (information presented from users is useful, they can provide

decision on the system functionality must be on the users' side.	meaningful information to patients).
Example 2	
As a user (logged in and subscribed to the health tracking using the sensorial system) I want to see my evolution, as well as make questions, receive recommendations and report to my parties (caregivers and health professionals). **Reason:** The information of the users will be protected and only authorised ones will access it. **Why?** as citizen I want to see my evolution (empowerment).	The health professional shall be able to go in the TeNDER Desktop.
Example 3:	
As a user (logged in and subscribed to the Health tracking) I want to see the information regarding the health tracking system in the smartphone app, in an easy to understand manner, with explanation of the data retrieved, to understand what TeNDER system does for me. **Reason:** I want to be empowered and have the control of my health with the information that TeNDER provides me.	The health professional shall accept the app/functionality
Example 4:	
As a user (logged in), I want to be able to see the historical information of my relevant symptoms and its occurrence.	and performance (information presented from users is useful, they can provide meaningful information to patients).
General Services of TeNDER:	
Example 1 the calendar:	
As a User (logged in), I want to see all my important events, including medical appointments, social events, and recommendations. **Reason:** I want a central place to access all significant events for me.	
Example 2 the reminders:	
As a user (logged and subscribed to the Health Tracking), I want to receive reminders, in case the system can (i.e. reminder about the medications). **Reason:** I want to be aware of the TeNDER functionalities to improve my health condition.	
Service Recommendation Engine:	
Example 1:	

As a user (logged in) I want to be able to receive the recommendations provided by TeNDER system and be able to differentiate these from the other messages from TeNDER. **Reason:** I do not want to be spammed, just to have a look to the messages that I want and I can identify.

As a user I want to be able to receive the recommendations and suggestions of social events provided by the social workers, being able to understand these, seeing them in my personal calendar.

Example 2:

As a user (logged in) I want to be able to decide which type of recommendations I want to receive. TeNDER system will be designed to provide diverse type of recommendations.

Service: TeNDER Communication

Example 1:

As a user of the TeNDER system (logged in) I want to be able to contact my roles (i.e. caregiver or health doctor) to communicate a special situation to them.

Additionally, as end user, I want to allow, (under authorization) that my linked roles (i.e. health professionals, caregivers) send me out messages through the TeNDER app.

Example 2:

As a user of the TeNDER system (logged in) I want to be able to see the historical of the conversations that I have had with my professionals.

TeNDER Virtual Assistance:

Example 1:

As a user of TeNDER (subscribed to the health tracking system and logged in) I want to check whether the system can support me in an activity.

Example 2:

As a user o TeNDER (subscribed to the health tracking system and logged in) I want to decide when and how I want to listen the

recommendations and support of the Virtual Assistance.

User: Caregiver

Service: Registering and Logging

Example 1:

As a user interesting in TeNDER, I can register in the APP, being able to see what the implications of it (previously informed) are as well as my rights and duties. The consent must be clear and easy to understand.

Example 2:

As a TeNDER user I want to be able to login to TeNDER app to securely access to my account. Reason: The information of the users will be protected and only authorised ones will access it. Why? as citizen I want to see my evolution (empowerment).

Example 3:

As a TeNDER user (registered & logged in), I want to access all services available in the app. I want to quickly access services from there. The design shall be intuitive, and in accordance with my understanding/comprehension of technology.

Service: Data Access

As a TeNDER user (logged in) I should be able go to the services, having fast access to my personal data (in a personal data area). I want to be able to insert data, as well as remove data.

As a caregiver, I want to be able to send a request to my familiar/beloved. I want to see her/his data only if He/she approved it.

As a caregiver, I want to decide whether a health professional can see my data or not.

As a caregiver, I want to decide whether several health professionals can access my data or not

As a caregiver, I want to decide whether grant access to a physiotherapist or not

As a caregiver, I want to decide whether grant access to a social worker or not.

As a caregiver, I want to decide whether several social workers can access my data or not.

As a user, I want to be able to decide whether I wish or not my data to be shared with the diverse roles, being able to unlink with them

Service: Health Tracking & Data Visualization

Example 1:

As a TeNDER user (logged in and linked to my patient/familiar), I want to decide when I wish the TeNDER Multi-sensorial system to be disconnected. **Reason**: the final decision on the system functionality must be on the users' side.

Example 2

As a user (logged in and linked to my patient/familiar) I want to his/her evolution, as well as make questions, receive recommendations and report to my parties (health professionals). **Reason**: The information of the users will be protected and only authorised ones will access it.

Example 3:

As a user (logged in and linked to my patient/familiar) I want to see the information regarding his/her health tracking system (if subscribed) in the smartphone app, in an easy to understand manner, with explanation of the data retrieved, to understand what TeNDER system does for me. **Reason**: I want to be empowered and have the control of my health with the information that TeNDER provides me.

Example 4:

As a user (logged in and linked to the patient), I want to be able to see the historical information of

him/her relevant symptoms and its occurrence If allowed.

General Services of TeNDER:

Example 1 the calendar:

As a User (logged in), I want to see all my important events, including medical appointments (and the ones of my patient if these are available), social events and recommendations for him/her and for me. **Reason**: I want a central place to access all significant events for me.

Example 2 the reminders for my patient:

As a user (logged and linked to my beloved/cared), I want to decide whether I want to receive his/her reminders in case the system can (i.e. reminder about the medications). **Reason**: I want to be aware of the TeNDER functionalities to improve my health condition.

Example 3 the reminders for me:

As a user (logged in) I want to access all my events, including the recommendations that the social worker could send to me, and the system recommendations.

Example 4 Alerts reporting:

As a caregiver (linked to my patient) I want to be notified if my patient suffers one of the most important events (either falls or leaving the house). **Reason:** It requires immediate attention.

Service Recommendation Engine:

Example 1:

As a caregiver (logged in) I want to be able to receive the recommendations provided by TeNDER system to my patient (and be able to differentiate these from the other messages from TeNDER). **Reason**: I do not want to be spammed, just to have a look to the messages that I want, and I can identify.

Example 3:

As a caregiver (logged in) I want to be able to receive the recommendations and suggestions of social events provided by the social workers, being

able to understand these, seeing them in my personal calendar.

Example 4:

As a user (logged in) I want to be able to decide which type of recommendations I want to receive. TeNDER system will be designed to provide diverse type of recommendations.

Service: TeNDER Communication

Example 1:

As a user of the TeNDER system (logged in) I want to be able to contact my roles (i.e. patient or his/her health doctor) to communicate a special situation to them.

Additionally, as end user, I want to allow, (under authorization) that my linked roles (i.e. health professionals, caregivers) send me out messages through the TeNDER app.

Example 2:

As a user of the TeNDER system (logged in) I want to be able to see the historical of the conversations that I have had with my patient and health professionals.

TeNDER Virtual Assistance:

Example 1:

As a user of TeNDER (subscribed to the health tracking system and logged in) I want to check whether the system can support me in an activity.

Example 2:

As a user o TeNDER (subscribed to the health tracking system and logged in) I want to decide when and how I want to listen the recommendations and support of the Virtual Assistance.

User: Health Professional

Service: Registering and Logging

Example 1:

As a user interesting in TeNDER, I can register in the APP (Desktop for health professional), being

able to see what the implications of it (previously informed) are as well as my rights and duties. The consent must be clear and easy to understand.

Example 2:

As a TeNDER user I want to be able to login to TeNDER app/Desktop to securely access to my account. **Reason**: The information of the users will be protected and only authorised ones will access it.

Example 3:

As a TeNDER user (registered & logged in), I want to access all services available in the app/Desktop. I want to quickly access services from there. The design shall be intuitive, and in accordance with my understanding/comprehension of technology.

Service: Data Access

As a TeNDER user (logged in) I should be able go to the services, having fast access to my personal data (in a personal data area). I want to be able to insert data, as well as remove data.

As a health professional, I want to be able to send a request to my patient. I want to see her/his data only if He/she approved it.

Example 2:

As a TeNDER health professional (Logged in) I want to be able to search my patient and link to him/her for having access to his/her data. **Reason:** Health professionals will access information from patients if and only if they authorise it.

Example 3:

As a TeNDER health professional (Logged and linked to my patient), I want to follow up the information of a patient. **Reason:** Health professionals will access information from patients if they authorise it. **Why?** The knowledge derived from the monitoring system can be useful for the health professional to optimise treatment

Example 4:

As a health professional (Logged and linked to my patient) I want to be able to track the patient's evolution of physical (i.e. Felt down) and behavioural (i.e. patient disoriented) activity and be able to launch (create) new recommendations if considered. **Reason**: The active monitoring and the improvement and optimisation of the patient's condition.

General Services of TeNDER:

Example 1 the calendar:

As a User (logged in), I want to see all events, including medical appointments (and the ones of my patient if these are available).

Example 2 the reminders for my patient:

As a health professional (logged in) I want to be able to observe the recommendations that the system provides to my patients.

Example 4 Alerts reporting:

As a caregiver (linked to my patient) I want to be notified if my patient suffers one of the most important events (either falls or leaving the house) if I want it and the patient accept it.

Example 5 Data visualization:

As a health professional, I want to be able to see reports of the health events (symptoms and signs) of my patient.

Service Recommendation Engine:

Example 1:

As a caregiver (logged in) I want to be able to receive the recommendations provided by TeNDER system to my patient (and be able to differentiate these from the other messages from TeNDER). **Reason**: I do not want to be spammed, just to have a look to the messages that I want, and I can identify.

Example 2:

As a health professional (logged in) I want to be able to provide customized recommendations, as well as creating rules to my patients.

	Service: TeNDER Communication **Example 1:** As a user of the TeNDER system (logged in) I want to be able to contact my roles (i.e. patient or health doctor) to communicate a special situation to them. Additionally, as end user, I want to allow, (under authorization) that my linked roles (i.e. health professionals, caregivers) send me out messages through the TeNDER app. **Example 2:** As a user of the TeNDER system (logged in) I want to be able to see the historical of the conversations that I have had with my patient and other health professionals.	

B   Hospital scenario

AD HOSP 1	**CASE 1**

Jane is a 78-year-old early-stage Alzheimer's patient who lives with her husband David at The Alzheimer's Therapy Centre. Their apartment consists of 3 rooms: a bedroom with a closet and two beds, a living room with seating options, a table, and a television, which leads to a balcony or terrace, and a small bathroom with toilet, sink and shower. David is a little worried because recently he has noticed that Jane gets extremely nervous for no reason and starts to perform tasks that she does not finish, such as, opening windows, opening taps, going in and out of the apartment and starts to move around terribly upset. Sometimes she is even aggressive, which makes David suffer.

The health care professionals at The Alzheimer's Therapy Centre are concerned about Jane and David's safety and well-being, especially during the hours when Jane and David are alone. They would like to detect when Jane begins to have this nervous

breakdown so that they can anticipate any situation that could threaten their safety, or detect an alarm situation so that they can come to the rescue on time.

In this scenario, the sensory equipment should be able to detect abnormal movements in the patient, such as: nervousness, repetitive movements, abnormal night-time activity, to notify and alert on the situation. For this purpose, real-time indoor monitoring and location will be implemented. All patients will be equipped with a lightweight commercial smart band and a Bluetooth scanner will be installed in each room. The selected band will have a long battery life (at least 10 days) and will be water resistant. The Bluetooth scanner is a small, inconspicuous device that monitors the strength of the band signal and calculates the user's position relative to the floor. The Bluetooth scanner will also connect to local Wi-Fi through local routers and will be able to transmit raw data directly to the cloud or locally to the attached storage and send data/reports to the cloud only when critical events occur.

Notifications and alerts will be sent when critical events occur on the mobile devices of the caregivers and reports provided under request to the health care professionals involved, including real time alerts to hospital professionals when requested by them.

abnormal movements nervousness, repetitive movements, abnormal night-time activity

localization monitoring,

+ alerts

EPIC	USER STORY (US)	Acceptance criteria
->Introduction -> type of user/role: **Type of user:** **Primary**: Patient (AD) **Secondary**: Caregivers and Health Professionals -> service/device/TeNDER module **Devices:** • Smartphone; • Smart band; • Bluetooth scanner;	**Example 1:** As a health professional, I want to receive alerts and notifications on a smartphone when a critical event about a patient occurs to promptly act upon it or dispatch a team.	I can log in with my health professional credentials in the mobile app while connected to Wi-Fi or mobile data After logging, I can see push notifications linked to patients. Notifications include: - timestamp of event - description of event - user id - user name

		- status of event - other metadata
Modules: -TeNDER smartphone app -TeNDER multi-sensorial system **Services**: • Active Sensorial continuous monitoring, warning, and reporting; • Pathway Tracking; • Communications; ->Outcomes System requirement **Outcomes System Requirement:** • Movement tracking; • Recognition of unusual behaviours; • Mood change detection; ->Outcome Visual interfaces - Notifications; - Reports; - Mobile App; - Dashboard;	**Example 2:** As a health professional, I want to see behavioural analysis data of my patients in a dashboard to correlate their conditions and their response to medication and other activities.	I can log in with my health professional credentials in the web app while connected to Wi-Fi After logging, I can see a dashboard with my patients' data. Dashboard shows: - mood charts - alerts of behavioural change - medication information - timestamps
	Example 3: As a health professional, I want to receive alerts and notifications on a smartphone when the Bluetooth scanner detects the patient(s) with a smart band has left the apartment to promptly act upon or dispatch a team.	I can log in with my health professional credentials in the mobile app while connected to Wi-Fi or mobile data After logging, I can see push notifications linked to patients. Notifications include: - timestamp of event - description of event - user id - user name - status of event

		- other metadata
	Example 4: As a health professional, I want to see geolocation patterns data analysis of my patient(s) in a map dashboard to analyse if the patient(s) are moving aggressively or erroneously (getting in and out repeatedly) to correlate their conditions and their response to medication and other activities.	I can log in with my health professional credentials in the web app while connected to Wi-Fi After logging, I can see a dashboard with my patient's location history. Dashboard shows: - locations map - timestamps - abnormal behaviours
	Example 5: As a patient (David) I can report an incident (aggressive behaviour) or behaviour pattern (breakdown) with a mobile application or by pushing a panic button to alert the health professionals.	I can log in with my patient in the mobile app while connected to Wi-Fi or mobile data After logging, I can report an incident
	Example 6: As a patient (David) I can report an unfinished task with a mobile application (open taps, open drawers) to document the behaviour pattern for health professional analysis.	I can log in with my patient in the mobile app while connected to Wi-Fi or mobile data After logging, I can report an unfinished task

B. User stories for Parkinson`s disease

C Home set scenario

PD_HOME 1	CASE 1

Ian is a 73-year-old patient diagnosed with Parkinson's. He lives with his wife Anne, 70, who has difficulty walking. They fend for themselves and together they do housework and meals.

Recently, the social worker has found that Ian is suffering from flare-ups of his disease so he is less well balanced and at risk of falling.

In addition, when she has visited the couple at home, she has observed that it is cold, as they leave windows open without realizing it. Additionally, she notices that they use the stove without due precautions.

The social worker is concerned about the safety of both. She is worried that Ian will fall and no one will be warned. She would like to detect early when Ian and Anne are no longer safe living alone at their house. To do this, she needs to know how many times a day events arise that threaten Ian and Anne's safety.

In this scenario, the sensory equipment should be able to detect changes in home security and well-being, detecting situations such as: falls, status of lights and electrical appliances, status of room temperature and air quality, water spills in kitchen and bathroom, state of refrigerator doors, state of doors and windows (open/closed, locked/unlocked), state of kitchen and stoves, gas spills.

Notifications and alerts will be sent to the social worker and caregivers when critical events occur in real time. Delayed reports will be generated by TeNDER system on the mobile or web devices of the caregivers and health professionals involved.

- Doors/windows open/closed

- Wandering, laziness (localization sensor)

- Freezing (Kinect and/or Fitbit)

- Festination (Kinect and/or Fitbit)

- Fall (Kinect and/or Fitbit and/or Voice tracker)

EPIC	USER STORY (US)	Acceptance criteria
-> type of user/role: <primary END-USERS> • Patient (PD) • legal representative <Secondary END-USERS>	**Example 1:** As a Patient or legal representative person, I want able to register with my own my personal account on the app through mail or SMS, after filling in a registration form Why? to securely access and manage my account.	As a patients or legal representative, I Must be able to register my account through simple form, filling g it with my credentials. As a patients or legal representative, I Must be able to

• **Carers and Informal Caregivers**		to access to TeNDER app, that must have a dedicated visual interface on tender
->Device		
• **TeNDER smartphone app.** • **PC box** • **Speaker** • **Microphone** • **Environmental sensors** • **Indoor localization sensor** • **Kinect and/or Fitbit**	**Example 2:** As patients or legal representative, I want to be able to deactivate all the service related to my mood and emotional status detection **(S1; S5)**, for instance switch off microphone and speaker or put in standby detection system through the app. Reason: the final decision on the system functionality must be on the users' side.	The interfaces must be user-friendly and making able users to switch off services remotely by app**.**
->TeNDER module dependencies • **Multi-Sensorial Capturing** Module • **abnormal Behaviour detection module** • **multi-Modal Fusion** • **virtual assistant module**	**Example 3:** As a patients or legal representative, I want to access my personal data in TeNDER app. I want to see who can see my status and receive summary report. Why? The information of the users will be protected and only authorised ones will access it.	As a patients or legal representative, I Must be able to to access to TeNDER app, that must show me who has access to my data and give me the opportunity to deny access.
->TeNDER Service • **S1: Active Sensorial Continuous Monitoring, Warning and Reporting** • **S3: Data analysis & Personalised Recommendations** • **S5: Virtual Assistance** • **S6: Communication** ->Functionalities requirements • **Emotional state detection;**	**Example 4:** As a Caregiver/ care and informal caregiver or I want able to register with my own my personal account on the app through mail or SMS, after filling in a registration form Why? to securely access and manage my account.	As a secondary end-user, I Must be able to register my account through simple form, filling g it with my credentials. I Must be able to to access to TeNDER app, that must have a dedicated visual interface on tender for a Caregiver/ care and informal caregiver.

• **Safety and wellbeing at home;** ->Outcomes System requirement • **Emotional status (sad, happy);** • **Fall detection** ->Outcome Visual interfaces of the APP - Notifications; **-** Summary reports	**Example 5:** As a Carers, Informal Caregivers, and familiars, I want be able to ensure safety and wellbeing at home of my patients, specifically be aware if/when he/she fell off, through automatic Fall detection service of Virtual assistance and therefore **(S5)** plus with another TeNDER suite service's signal coming from the Kinect **(S1).** Notifications on my smartphone (TeNDER APP, dedicated visual interface). Why? to immediately intervene or call for helps.	As a Secondary End-user must be able s to set up grade of urgency on the app per each event Notifications include: -timestamp of event -description of event - user id - user name - status of event - other metadata
	Example 6: As a <Carers, Informal Caregivers, and familiars>, I want be able to know about emotional and state of patients, specifically to be aware of when patients crying or laughing or he/she is become, angry, apathetic, through <automatic emotional and mood detection micro services **S1; S5)**, to <know his/her mood status and therefore receiving notification on my smartphone (TeNDER APP, dedicated visual interface) Why? to track of potential mood disorders or intervene in case of frequently repetitive events>.	As a Secondary End-user must Have smartphone, abilities to receive notifications by tender. Notifications include: -description of event - user id - user name - status of event - other metadata

D   *Day care centre scenario*

PD DAY CARE CENTRE	
Description or details of -> Scenario (Storytelling)	

Miguel is a 72-year-old patient, diagnosed with Parkinson's and living in an elderly home. In his free time, he spends his time walking around the centre and its

surroundings. His relatives have shared the professionals at the care centre their concern, as they consider that on certain days Miguel's mobility and balance do not allow him to move around safely and insist that on those days Miguel could fall during his walks. They ask that he should not be allowed to walk by himself on that days. This situation is complicated for the professionals at the centre, as Miguel is an independent and active man and does not like to be accompanied everywhere. For this reason, both the professionals and Miguel's family would like to be able to be warned in case Miguel starts the day with more difficulty of movements and would be warned if he needs help during his walks.

In this scenario, the sensory team should be able to detect wandering, laziness, and the presence of slower or abnormal movements in the patient, to be able to notify that his mobility situation has worsened; as well as to detect his location and if he falls, freezes, or have gait difficulties. For this purpose, real-time indoor location will be implemented in the private home. All patients will be equipped with a lightweight commercial smart band and a Bluetooth scanner will be installed in each room. The selected band will have a long battery life (at least 10 days) and will be water resistant. The Bluetooth scanner is a small, inconspicuous device that monitors the strength of the band signal and calculates the user's position relative to the floor. The Bluetooth scanner will also connect to local Wi-Fi through local routers and will be able to transmit raw data directly to the cloud or locally to the attached storage and send data/reports to the cloud only when critical events occur.

Notifications and alerts will be sent when critical events occur on the mobile devices of the caregivers and professionals involved. Participants will have the option to access the notification server via the web application on personal mobile devices.

- wandering, laziness (localization sensor)

- freezing (Kinect and/or Fitbit)

- Festination (Kinect and/or Fitbit)

- fall (Kinect and/or Fitbit and/or Voice tracker)

EPIC	USER STORY (US)	Acceptance criteria

Type of user:	User: Patient	
Primary: User (Patient)		
Secondary:	**Example 1:**	As a user (patient) must be able (or be trained) to see his/her medical file.
-Caregivers (Family)	As a TeNDER user I want to be able to see my medical file on the cloud. Reason: I want to see my evolution as well as make questions to Health Professionals.	
-Health Professionals		
Day-Care CENTER		
Modules:		
-TeNDER smartphone app. or the WebApp.	**Example 2:**	As a user (patient) must be able (or be trained) to use TeNDER APP.
-TeNDER multi-sensorial system	As a TeNDER user I want to be able to notify the caregiver whenever I need him. Reason: I want to feel safe.	
Services:		
-S1--S3: Data analysis & Personalised Recommendations		
-S5: Virtual Assistance		
-S6: Communication		

	User: Caregiver	
	Example 1:	
	As a TeNDER user (and subscribed & logged) I want to have access to medical history of the patient. Reason: I want to know if the patient needs help during his walks.	As a user (caregiver) must be able (or be trained) to use TeNDER app.
	Example 2:	
	As a TeNDER user (and subscribed & logged) I want to be informed immediately when a sudden change at the patient's mobility status occurs. Reason: I want to help the patient regarding his mobility situation.	As a user (caregiver) must be able (or be trained) to use TeNDER app.
	User: Health Professional	
	Example 1:	

	As a health professional (Logged and linked to my patient) I want to have access to the Cloud to be able to see my patient's medical file on my account. Reason: I want to be able to give recommendations to my patient when it is necessary. **Example 2:** As a health professional (Logged and linked to my patient) I want to have access to the Cloud to be able to see my patient's medical file on my account. Reason: I want to be able to see the evolution of my patient and regarding this I could give the most suitable prescription to my patient.	Professional comfortability with the system in terms of: acceptance (easy to use) and performance (information presented from users is useful, they can provide meaningful information to patients). User comfortability with the system in terms of: acceptance and performance.

E   Hospital scenario

PD- HOSP	
Fred is a 77-year-old patient in the hospital. Fred has Parkinson's disease and complains of lack of sleep. Health professionals noticed that Fred gets up a lot during the night to go to the bathroom and are concerned that he does so without warning and is not in good physical condition to walk alone as he could fall. In this scenario, the sensory equipment must be able to detect night-time activity in the room, as well as detect and warn of a fall. It will also detect the quality of the patient's sleep. To do this, a real-time location will be implemented inside the room. All patients will be equipped with a lightweight commercial bracelet and a Bluetooth scanner will be installed in each room. The selected band will have a long battery life (at least 10 days) and will be water resistant. The Bluetooth scanner is a small, discreet device that monitors the strength of the band signal and calculates the user's position in relation to the floor. The Bluetooth scanner will also connect to the local Wi-Fi network through local routers and will be able to transmit raw data directly to the cloud or locally to the attached storage and send data/reports to the cloud only when critical events occur.	

Notifications and alerts will be sent when critical events occur on the mobile devices of the caregivers and reports provided under request to the health care professionals involved, including real time alerts to hospital professionals when requested by them.

Sleep tracker

Fall detection

Localization

Binary sensor (toilet door)

EPIC	USER STORY (US)	Acceptance criteria
Type of user: **Primary**: Health Professionals Caregivers **Secondary**: Patient (PD) -> service/device/TeNDER module **Devices:** • Smartphone; • bracelet; • Bluetooth scanner; **Modules**: -TeNDER smartphone app -TeNDER multi-sensorial system	**Example 1:** As a health professional, I want to receive alerts and notifications on a smartphone when a critical event about a patient occurs to promptly act upon it or dispatch a team.	I can log in with my health professional credentials in the mobile app while connected to Wi-Fi or mobile data After logging in, I can see push notifications linked to patients. Notifications include: - timestamp of event - description of event - user id - user name - status of event - other metadata
Services: • Active Sensorial continuous monitoring, warning, and reporting; • Pathway Tracking; • Communications;	**Example 2:** As a health professional, I want to see behavioural analysis data of my patients in a dashboard to correlate their conditions and their response to medication and other activities.	I can log in with my health professional credentials in the web app while connected to Wi-Fi After logging in, I can see a dashboard with my patients' data. Dashboard shows:

->Outcomes System requirement **Outcomes System Requirement:** • Movement tracking; • Recognition of unusual behaviours;		- mood charts - alerts of behavioural change - medication information - timestamps
->Outcome Visual interfaces - Notifications; - Reports; - Mobile App; - Dashboard;	**Example 3:** As a health professional, I want to receive alerts and notifications on a smartphone when the Bluetooth scanner detects the patient(s) with a bracelet has left the apartment to promptly act upon or dispatch a team.	I can log in with my health professional credentials in the mobile app while connected to Wi-Fi or mobile data After logging in, I can see push notifications linked to patients. Notifications include: - timestamp of event - description of event - user id - user name - status of event - location metadata - other metadata
	Example 4: As a health professional, I want to see geolocation patterns data analysis of my patient(s) in a map dashboard to analyse if the patient(s) are moving aggressively or erroneously (getting in and out repeatedly) to correlate their conditions and their response to medication and other activities.	I can log in with my health professional credentials in the web app while connected to Wi-Fi After logging in, I can see a dashboard with my patients' data.

		Dashboard shows: - indoor location traces - heatmap of location traces - KPIs about rooms visited - KPIs about number of times patients leave specific areas (defined by geofence) with timestamped event logs
	Example 5: As a health professional, I want to receive alerts and notifications on a smartphone when the sensory system detects a fall to promptly act upon or dispatch a team.	I can log in with my health professional credentials in the mobile app while connected to Wi-Fi or mobile data After logging in, I can see push notifications linked to patients. Notifications include: - timestamp of event - description of event - user id - user name - status of event - location metadata - other metadata

F   Rehabilitation room scenario

PD REHAB. ROOMD	

Lisa is 72 years old, diagnosed with Parkinson's. Twice per week, she goes to a rehabilitation centre to maintain and improve her muscle tone and mobility to keep autonomous if possible, her situation is changing and it seems that her ability to move has worsened in recent months.

Maria is a physiotherapist at the centre and she would find it helpful to know Lisa's mobility status based on objective and accurate data. Maria would like to know the data of the activity and movements that Lisa does in each rehabilitation session to measure the evolution and personalize therapies. With this knowledge, they could make a more individualized exercise chart and pay more attention to Lisa's situation.

In this scenario, the Kinect and the bracelet should be able to detect movement evolution   in the patient, to be able to notify that his mobility situation has worsened; as well as to detect if there is a loss of balance and/or festination to perform additional exercises as prevention of falls. . A Kinect camera will be set up in the rehabilitation centre. This equipment must have voice recognition to be commanded by voice for physiotherapists. The bracelet will be provided to all patients to provide health measurements to professionals.

  All patients will be equipped with a lightweight commercial smart band and a Bluetooth scanner will be installed in each room in their own homes. The selected band will have a long battery life (at least 10 days) and will be water resistant. The Bluetooth scanner is a small, inconspicuous device that monitors the strength of the band signal and calculates the user's position relative to the floor. The Bluetooth scanner will also connect to local Wi-Fi through local routers and will be able to transmit raw data directly to the cloud or locally to the attached storage and send data/reports to the cloud only when critical events occur. The purpose is to detect if there is loss of balance and/ or festination when they are out of the rehabilitation centre to inform his/her physiotherapist and work with additional exercises as fall prevention.

Notifications and alerts will be sent when critical events occur on the mobile devices of the health professionals (mainly physiotherapists) involved that request it. Participants will have the option to access the notification server via the web application on personal mobile devices and to have additional exercises recommendations selected by their own physiotherapist.

EPIC	USER STORY (US)	Acceptance criteria
-> type of user/role: <primary END-USERS>	As a physiotherapist, I want to receive a report in my TeNDER app about the movement evolution of the exercises performed on the rehabilitation room, in a period of time for each patient (select by myself). **#Use Story**	I can log in with my health professional credentials in the TeNDER app while connected to Wi-Fi or mobile data

• **Health professional (physiotherapists)** • <Secondary END-USERS> Patient ->Device Smartphone; Bracelet; Bluetooth scanner Kinect with voice command integrated.		After logging in, I can choose the period of time and patients and have the report Report include: - description of exercise - user id - user name - evolution of the performance - other metadata
->TeNDER module dependencies: • **TeNDER smartphone app** • **TeNDER multi-sensorial system.** • **Kinect with voice command.** - >TeNDER Service • **Active Sensorial continuous monitoring, warning, and reporting;** • **Movement evolution Tracking;** • **Communications;** ->Functionalities requirements • **Movement tracking** ->Outcomes System requirement	As a physiotherapist, I want to receive a report in my TeNDER app about the movement evolution at home, especially the number of loss of balance or festination detected at home in a period select by myself and for each patient. .	As a <type of user/role>, <Must be able to […]> And service/device <Must have […] > <Must feature […] > <Must be able to […]> I can log in with my health professional credentials in the TeNDER app while connected to Wi-Fi or mobile data After logging in, I can choose the period of time and patients and have the report Report include: - number of loss of balance and /or festination - user id - user name - other metadata

• **Recommendations** • **Communication channel.** ->Outcome Visual interfaces of the APP • **Notifications;** • **Reports;** • **Mobile App;** • **Dashboard;**	As a physiotherapist, I want to send exercises recommendations using the TeNDER app for a selected patient considering the information about the movement evolution provided by TeNDER system and have a channel communication with my patients.	As a <type of user/role>, <Must be able to […]> And service/device <Must have […] > <Must feature […] > <Must be able to […]> I can log in with my health professional credentials in the TeNDER app while connected to Wi-Fi or mobile data After logging in, I can choose some exercises from a database exercises and send it to a patient or patients' group. _Communication with a patient -Communication with a patient group. - user id - user name - other metadata
	As a <type of user/role>, What <I want some Functionalities] When <some event> For some <goal [outcome]> <why [some reason]>	As a <type of user/role>, <Must be able to […]> And service/device <Must have […] > <Must feature […] >

	As a physiotherapist I want to use the Kinect system using voice command to manage the TeNDER system.	<Must be able to […]>I can use the Kinect camera in the rehabilitation room during the sessions using voice command and the system is able to recognize my commands.
	#Use As patient affected by Parkinson´s disease, I want to see the exercises recommendations provided by my physiotherapist and have a communication channel.	I can log in with my patient credentials in the TeNDER app while connected to Wi-Fi or mobile data Report about my patient evolution exercises doing in my rehabilitation sessions. Personalized exercises recommendations provided by my physiotherapist. Communication channel with my physiotherapist.

C. User stories for cardiovascular disease

C.1 Homeset scenario

CVD_HOME_1	
George is a 62-year-old patient diagnosed with mild heart failure and suffering from high blood pressure. He lives alone and lately his blood pressure control is not being effective. George goes out every morning to do his walk and exercise routine prescribed by the cardiologist. But lately, he	

has noticed that he gets tired more easily and feels a little dizzy. Both George and his family fear that he may suffer a cardiac event during his walks.

Health professionals are concerned about George's situation, as he may be experiencing a change in his heart condition. They would like to know George's vital signs both when he is at home relaxing and during his exercise routine (such as heart rate, blood pressure, breathing rate)

For this use case/scenario, all patients will be equipped with a light commercial bracelet that detects vital signs of heart rate, SPO2 and breathing rate. The bracelet selected will have a long battery life (at least 10 days) and will be waterproof. It can be worn all the time without removing it. The Bluetooth scanner will also be connected to local Wi-Fi through local routers and will be able to transmit raw data directly to the cloud or locally to an attached storage and send data / reports to the cloud only when critical events occur.

Notifications and alerts will be sent when critical events occur on the mobile devices of the caregivers and professionals involved. Participants will have the option to access the notification server via the web application on personal mobile devices.

EPIC	USER STORY (US)	Acceptance criteria
-> type of user/role: <primary END-USERS> • **Patient (CVD)** <Secondary END-USERS> • **Health professional** • **Caregivers** ->Device	**Example 1:** As a Health professional I want to be able to register with my own personal account on the app through mail or SMS, after filling in a registration form Why? to securely access and manage my account	As a Secondary End-user I can log in with my health professional credentials in the mobile app while connected to Wi-Fi or mobile data
• **Fall detection** • **TeNDER smartphone app.** • **PC box** • **Bracelet** ->TeNDER module dependencies: • **TeNDER multi-sensorial system** • **Multi-Modal Fusion**	**Example 2:** As a Health professional I want to be able to know about a patient's heart condition, specifically to be aware when devices detect an unusual signal of blood pressure, breathing rate**(S1)** therefore receiving notification on my smartphone (TeNDER APP, dedicated visual interface) Why? in or intervene in case of this events or calling for help	As a Secondary End-user After logging, I can see push notifications linked to patients. Must Have smartphone setting to receive notifications by TeNDER services related to the movement tracking,

• **Data Analytics and Recommendation** ->TeNDER Service • **S1: Active Sensorial Continuous Monitoring, Warning and Reporting** • **S3: Data analysis & Personalised Recommendations** • **S6: Communication**		Heart rate, physical activity of my patients. Device/bracelet must be provided with a long battery life (at least 5 days) and will be waterproof
->Functionalities requirements • **Safety and wellbeing at home;** ->Outcomes System requirement • **Movement tracking** • **Recognition of unusual behaviours** • **Heart rate, physical activity**	**Example 3:** As a patient I want to be able to visualize on the APP my calendar to check prescribed routine exercise today and have a track record. Why? I want to track my progress	As a patient I Must be able to to access to TeNDER app, that must have a dedicated visual interface on tender App. The APP must be user-friendly and making able users to switch off services remotely by app**.**
->Outcome Visual interfaces of the APP • **Calendars** • **Notifications** • **Summary reports**	**Example 4:** As a health professional I want to be able to modify the exercise routine prescribed, with the view to modify treatment (for instance increase or decrease drug dosages when it is necessary), according to the effective intake of medication (measured by the system).	As a Secondary End-user I must be able to set up and modify exercise routine prescribed

C.2 Day care centre scenario

CVD_DC_1	
Antonio is a 62-year-old patient who has mild cardiovascular disease. In the last few months, his health has worsened following a hospital admission for heart failure. His son is concerned because he has noticed that Antonio has become less communicative and stays locked up in his apartment for a long time. In the mornings he goes to a day centre, where the workers and his friends have also noticed him sad and in low spirits. People close to Antonio are worried about his mood. In this scenario, an affective computing module will be employed that will apply advanced techniques of deep learning and computer vision to extract relevant characteristics (i.e., general, facial, speech, or behavioural) that can allow for the estimation of patients' expression and mood. This information will be extracted using smart phone devices and used as input for higher level services that will support the patient. Notifications and alerts will be sent when critical events occur on the mobile devices of the caregivers and professionals involved. Participants will have the option to access the notification server through the web application on personal mobile devices.	

EPIC	USER STORY (US)	Acceptance criteria
	Example 1: As an online customer (-> type of user/role) I want to be able to login (-> Functionalities requirements) to securely access to my account [some reason]. **Example 2:** As a subscribed user (-> type of user/role) I want to migrate all my data backup (-> Functionalities requirements) in a cloud system to free up my device [some reason].	

	Example 1: As a health professional (-> type of user/role) I want to be able to (->Functionalities requirements) view the status of ongoing treatment (->Outcome Visual interfaces) so that I can plan when to deliver results to my patients (->Outcomes System requirement)	
	Example 1: As a patient (-> type of user/role) , I want to be able to see my medical file on my account (->Functionalities requirements; –>Outcome Visual interfaces) , so that I receive feedback from health professional (->Outcomes System requirement)	
	Example 1: As a software tester (-> type of user/role) when I log a defect under each developer's name, I want each of them to receive a notification because then the developer will then be aware of the defects, I logged	

C.3 Hospital scenario

CVD_HS_1
Carol is a 74-year-old patient who has been admitted to the hospital for cardiovascular disease. These past few days, Carol says she loses breath when she goes to the bathroom and feels dizzy. Her family and health care professionals are concerned about the situation, which may be getting

worse. They would like to know the vital signs of Carol at the time she goes to the bathroom (heart rate, blood pressure, respiratory rate).

For this scenario, all patients will be equipped with a light commercial bracelet that detects vital signs of heart rate, blood pressure, breathing rate. The selected bracelet will have a long battery life (at least 10 days) and will be waterproof. It can be worn all the time without removing it. The Bluetooth scanner will also be connected to local Wi-Fi through local routers and will be able to transmit raw data directly to the cloud or locally to an attached storage and send data / reports to the cloud only when critical events occur.

Notifications and alerts will be sent when critical events occur on the mobile devices of the caregivers and reports provided under request to the health care professionals involved, including real time alerts to hospital professionals when requested by them.

EPIC	USER STORY (US)	Acceptance criteria
	User: Patient	As a patient, I must be able to login to TeNDER app and check my data. The service must have button to stop collecting data.
Type of user: Primary: Health Professionals Secondary: Patient **Rehabilitation**	**Example 1:** As a TeNDER user I want to be able to login to TeNDER app to securely access to my account. **Reason**: The information of the users will be protected and only authorised ones will access it. **Why**? as user I want my data is securely stored and protected.	
Modules: TeNDER smartphone app. **Services**: **S3**: Data analysis & Personalised Recommendations **S5**: Virtual Assistance **S6**: Communication	**Example 2:** As a TeNDER user (and subscribed & logged), I want to access my personal data in TeNDER app. I want to see my evolution, as well as make questions, receive recommendations and report to my parties (caregivers and health professionals). **Reason**: The information of the users will be protected and only authorised ones will access it. **Why**? as citizen I want to see my evolution (empowerment). Services: S3, S5 & S6 **Example 3:**	

	As a TeNDER user (and subscribed & logged), I want to decide when I wish the TeNDER Multi-sensorial system to be disconnected. **Reason**: the final decision on the system functionality must be on the users' side. **Why**? User do not want to share all the data.	
	__User: Health Professionals__	As health professional, I must be able to login to TeNDER app and check my patients' data.
	Example 1: As a TeNDER user I want to be able to login to TeNDER app to securely access to patients' data. **Reason**: The information of the users will be protected and only authorised ones will access it. **Why**? End-user data must be securely stored and protected.	
	Example 2: As a TeNDER user (and subscribed & logged in), I want to access patient data in TeNDER app. I want to see his/her evolution, as well as receive recommendations, and report to my patient. **Reason**: I want the system supporting me to decide what is best for my patient. **Why**? As a health professional, I want to track my patients' condition.	

3. Pilots Definition

TeNDER will perform 5 large scale pilots, involving 5 user partners and 1500+ TeNDER final users in 4 different European regions, with at least 735 patients (+40% in the patients control group, making a total of 1030 patients),85 health professionals (physicians mainly), 30 social workers, 570 caregivers (professional and relatives) and 60other staff (clerks, Hospital IT support, etc.), to provide tailor suited integrated care services to promote wellbeing and health recovery. TeNDER will provide 4 different scenarios according to the patients' pathways (home, day care centre, rehabilitation centre/rooms, and hospital).

3.1. Large Scale Pilots by Partner and Scenarios

REGIONAL MADRID HEALTH SYSTEM (SERMAS)						
PATIENTS DISEASE/CONDITION AND SEVERITY	Parkinson's and Alzheimer's patient's mild-moderate stages Cardiovascular co-morbidity					
SCENARIO OF THE PILOT	Primary Care Centres, Homes and Day Care Centres					
ACTORS INVOLVED (1248)	**Patients**		**Caregivers**	**Professionals**		
	Control Group (154)	Intervention Group (380)	(290)	Health P. (32)	Social P (10)	Others (24)

ASOCIACION PARKINSON MADRID (APM)						
PATIENTS DISEASE/CONDITION AND SEVERITY	Parkinson´s patients all severities					
SCENARIO OF THE PILOT	Rehabilitation room, day care centre and home set					
ACTORS INVOLVED (238)	**Patients**		**Caregivers**	**Professionals**		
	Control Group (38)	Intervention Group (95)	80	Health P. (15)	Social P. (2)	Others (8)

UNITOV (UNIVERSITY OF ROME "TOR VERGATA" HOSPITAL)					
PATIENTS DISEASE/CONDITION AND SEVERITY	Parkinson's and Alzheimer's patients all severities.				
SCENARIO OF THE PILOT	Homes, hospital				
ACTORS INVOLVED (176)	**Patients**		**Caregivers**	**Professionals**	
	Control Group (24)	Intervention Group (60)	60	Health P. (20)	Social P. (0)	Others (12)

THE SCHOEN CLINIC BAD AIBLING (SKBA)					
PATIENTS DISEASE/CONDITION AND SEVERITY	Patients with Alzheimer's disease (all severities) Patients with cardiovascular disease (stroke)				
SCENARIO OF THE PILOT	Alzheimer's Therapy Centre (ATZ), hospital				
ACTORS INVOLVED (231)	**Patients**		**Caregivers**	**Professionals**	
	Control Group (40)	Intervention Group (100)	60	Health P. (15)	Social P. (6)	Others (10)

SPOMINČICA - ALZHEIMER SLOVENIA (SPO)			
PATIENTS DISEASE/CONDITION AND SEVERITY	Persons expressing cognitive complaints, having cognitive impairments, or having diagnosis of Alzheimer or another disease-causing dementia		
SCENARIO OF THE PILOT	Homes, Day care centres		
ACTORS INVOLVED	**Patients**	**Caregivers**	**Professionals**

(240)	Control Group (40)	Intervention Group (100)	80	Health P. (10)	Social P. (4)	Others (6)

TeNDER's strategy is based on four phases that make up the pilots, each of which feeds into the next, so that an initial, intermediate, and final version of the project components is derived after the end of each phase. Research with actual end users will be passed on to the technical partners on a monthly basis to consider the limitations and suggestions found by real people testing the technology as it develops. The evaluation process involved in the co-design approach will be properly documented. In co-design process at least 20 participants will be involved. Those participants will be included in the piloting phase and in the validation phase, when available.

The following section describes each of the phases contained in the Grant Agreement (GA). After each phase, the following steps have been included to work on carrying out each phase. Thus, each phase builds on the results of the previous phase or phases, following a continuous internal process of converting the requirement into acceptance criteria as foreseen in the Agile methodology.

3.2. Pilots Phases

Phase 1: approach to the requirements, usability, and acceptance

Phase 1 (M1-M12), **user requirements** will be set which will allow for the definition of the **overall architecture.** Furthermore, throughout this phase, core developments of independent components will take place. Evaluation will start via **lab prototyping and testing**, identifying potential limitations and drawbacks. At this phase, most of the modules that will be employed in these activities **will reach and exceed TRL-6**, depending on their maturity at the starting point of the project and their dependence on other modules. Finally, from M15 a set of 20% patients that meet the inclusion criteria will be enrolled in all pilots.

To carry out the study of the end-users, it is required to design a cross-sectional descriptive observational study that explores their needs and acceptability through questionnaires and interviews. In this exploratory phase we will provide basic description that will be used for design of the study that includes pilots in second phase of the Project.

The participants will be recruited by the researcher in each of the five participating countries that will carry out piloting. The researcher will explain the participation is voluntarily to all persons that meet the selection criteria until the necessary sample size is reached. The sample size for each country in

the first phase is at least 20 patients, 20 carers/caregivers, and 10 participants from professional group in surveys and at least 9 interviews including users from patients, carers/caregivers, and professionals.

Questionnaires will be offered in two ways:

1.   In case of collecting feedbacks with questionnaires by post: person will be contacted by phone/personally and a brief explanation of the project will be given; if agreed, the questionnaire will be sent by post with stamped envelope inside and request to send back the filled questionnaire or asked to be filled, with offering assistance by the researcher that recruits the person. When collected, the questionnaire will be treated anonymously (in case collecting by post, divided from the envelope). Only the participants that will meet criteria described below will be included in the descriptive analysis.

2.   In case of web-based feedback: the candidates will be offered to access the link for filling in the anonymous questionnaire if they meet following criteria bellow.

The interview methodology allows to establish a closer relationship with the participants. Thus, we can collect the opinion of several elements, identify behaviours, concerns and disagreements. Interviews will be conducted with patients, caregivers (professional/family) and health professionals.

The interview will be divided into general topics:

- opening: giving a brief introduction of TeNDER and explanation;

- warming-up: participants introduce themselves, answering some questions about themselves that are relevant for the subject in discussion;

- focused questions: a transition between the previous very general exchanges and an increasingly specific questions and discussion of the issues to be covered will occur;

- closing: researcher' role is to summarize and recapping and eventually clarify some remaining issues.

Phase 2,3 and 4: Pilots' Implementation.

TeNDER project will create an integrated care ecosystem for assisting people with chronic diseases of Alzheimer's (AD), Parkinson's (PD) and Cardiovascular Diseases (CVD) facing comorbidities, using affect based micro tools.

These micro services will recognise the mood of a person and thus adapt the system's probes to the person's needs via a multi-sensorial system, even in the most severe cases, and match with clinical (from Electronic Health Records EHRs) and clerical patient information, while preserving privacy, monitoring the ethical principles, providing data protection and security, with the result of an increased Quality of Life (QoL). In addition, interactive communication and social services will strength

the elderly support, extending their autonomy and care supply chain. Regarding: usability, QoE and QoS, acceptance and other social variables of the investigation.

Phase 2 (M12-M18), a **working prototype will become ready**, in which the most updated versions of all the components will have been integrated. Additionally, **trials for demonstration of the system in relevant environments will occur**, targeting at least **TRL-7** in all components but activity recognition. Until M14 a baseline is established for each patient including number of hospital visits and bed-days, family integration in care etc. In M13, the first version of the platform **will be installed in the homes of 35 patients** for the **FIRST PHASE OF THE TRIAL**. Data obtained in this phase of the pilot will be used for updating the requirements definition. These are described in the following tables:

Phase 2 (M12-M18)	
First Wave CODESIGN/VALIDATION **PILOTS**	
Step A	Recruitment the users: patients, caregivers, and professionals. Sing the consent form.
Step B	Baseline visit to data collect. Pre-evaluation.
Step C	TeNDER devices testing. TeNDER system will be installed in 35 scenarios.
Step D	Interviews/Focus groups for usability, satisfaction, and efficiency. Data obtained will be used for updating the requirements definition for the Phase 3.

Table 2 Phase 2

Phase 3 or Second wave (M18-M24), the ecosystem will be ready to be validated and demonstrated in more realistic operating conditions, **ensuring TRL-7 or even TRL-8** in some components. In M23, an updated version of the platform will be installed and the **SECOND PHASE OF THE TRIAL** (M23-M28) will commence The TeNDER platform (devices, data transfer capabilities etc.) will be introduced to a subset of the patients as well as their treating physicians and relevant care providers, in particular their families. Then, from M29-31, TeNDER ecosystem will be updated based on the outcomes of the trials of this phase.

Phase 3 (M18-M24)
Second Wave **LARGE SCALE PILOTING**

Time	Intervention Group	Control Group
Recruitment	**a**	
Baseline visit	**b**	
	Randomization	
Intervention	**c** **d**	**c**
Results	T0 (PRE-Intervention) T1 (POST-Intervention)	

Table 3 Phase 3.

a **Recruitment** of patients (100%) by participating professionals based on the inclusion criteria and signing of informed consent.

b **Baseline visit** to data collect. Pre-evaluation: questionnaires and interviews from patients, caregivers and health/social professionals accord to KPIs.

c **Standard practice.** Follow-up and regular individual attention by health and social professionals.

d **TeNDER implementation:**
Installation of micro tools based on movement sensors and facial expressions in the participant's usual context. It involves:
  -Monitoring and data collection.
  -Communication network (patient-care workers-health-social professionals)

Table 4. List of indices for Pilot phases.

3.3. Detailed planning of each pilot

SERMAS pilot detail											
User Requirements											
Description: Professionals involved will conduct questionnaires and interviews with participants.											
Location: In Madrid primary health care centres											
Professionals involved: 5 health professionals											
Participants involved: 20 patients, 20 caregivers and 10 social-health professionals											
Data collection: Quantitative questionnaires and Qualitative interviews											
	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
To provide the necessary permissions and acceptances	X	X									
Recruit and train the researchers who will perform them	3 physicians		2 nurses								
Questionnaires: in 4 health centres.			10 patients 10 caregivers 10 social and	10 patients 10 caregivers							

			health professionals									
Interviews: in 4 health centres.			2 patients 1 caregiver 2 social and health professionals	1 patient 2 caregivers 1 social and health professional								
Data analysis			Database debugging	Analysis	Reporting of results							
First Wave Piloting												

Recruitment of the professionals participating

Description: Professionals involved will give several information sessions about the TeNDER project and interested professionals will register as participants.

Location: In Madrid primary health care centres and care centres.

Professionals involved: 3 family doctors, 1 FIIBAP and SERMAS researcher, 2 SERMAS researcher.

Participants involved: Health and social professionals; and health centre management staff.

Data collection: Quantitative record of the participants in each group.

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Preparation of session´s briefing material			X								
Development of the briefing's sessions			x	x							
Recruitment			11 social and health professionals	11 social and health professionals							

Training activity for professionals participating

Description: The professionals involved will carry out two training sessions. The first one, about the information, implementation, and methodology of the project. The second one will be to train them in the TeNDER tool and devices.

Location: In Madrid primary health care centres and care centres.

Professionals involved: 3 family doctors, 1 FIIBAP and SERMAS researcher, 2 SERMAS researcher, UPM technical partners.

Participants involved: Health and social professionals; and health centre management staff.

Data collection: Quantitative record of the participants in each group and Qualitative: Focal group

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Constitution of the teaching group			X								
Application and accreditation for the course			X								

Preparation of teaching materials			X								
Development of the training activity			4 sessions in 2 health centres	4 sessions in 2 health centres							
Focus group: in 2 health centres			6 participants	6 participants							
Data analysis			Database debugging	Analysis	Reporting of results						

Recruitment of patients and caregivers participating

Description: The professionals participating will inform patients and caregivers who meet the selection criteria and provide them with informed consent. With those who agree to participate, they will schedule two appointments:

- The first to assess the scenario and the possibility of installing the TeNDER tool. By technical partners.

- The second with the "survey researcher", who will be in charge of carrying out the questionnaires prior to the intervention. And there will be a focus group.

Location: In Madrid primary health care centres and care centres.

Professionals involved: 32 family and community doctors and nurses, 10 social workers, 24 health centre management staff, UPM technical partners.

Participants involved: 190 patients (AD, PD, CVD), 145 caregivers, 42 social and health professionals.

Data collection: Quantitative record of the participants in each group, Personal interviews, Qualitative: Focal group

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Recruitment						24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers		
Personal interviews						24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers		
Qualitative: Focal group						6 patients	6 caregivers	6 patients	6 caregivers		
Data analysis								Database debugging	Database debugging	Analysis	Reporting of results

Using the TeNDER tool

Description: During this phase will conduct direct observation and personal interview of each participant. Periodically, each institution will make reports indicating: number of participants, professionals involved, results and KPIs.

At the end of the pilot will be a focal group.

Location: Homes and day care centres

Professionals involved: 32 family and community doctors and nurses, 10 social workers, 3 family doctors, 1 FIIBAP and SERMAS researcher, UPM technical partners

Participants involved: 190 patients (AD, PD, CVD), 145 caregivers, 42 social and health professionals

Data collection: Personal interviews, Direct observation, Focal group

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
TeNDER tool							Reported		Reported		Reported
Personal interviews						24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers
Direct observation						24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers	24 patients 18 caregivers
Focus group							6 patients	6 professionals	6 patients 6	6 professionals	

								6 caregivers		caregivers		
Data analysis										Database debugging	Analysis	Reporting of results

APM pilot detail
User Requirements

Description: Researchers will conduct questionnaires and interviews to establish the user requirements. Due to the COVID-19 situation the questionnaires and interviews could be conducted by phone or call using Internet.

Location: Madrid. Asociación Parkinson Madrid Rehabilitation center (Calle Poeta Esteban Villegas, 12)

Professionals involved: 4 health professionals involved.

Participants involved: 20 patients affected by PD, 20 caregivers and 10 socio-health professionals.

Data collection: Quantitative Questionnaires and Qualitative Interviews.

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
To provide the necessary permission and acceptance.	x	x	x								
Recruitment and train the researchers who will perform them.	1 Psychologist	1 Psychologist	2 Therapeutics								
Questionnaires			10 socio-health professionals	16 patients and 16 caregivers	4 patients and 4 caregivers						
Interviews			2 socio health professionals	1 socio health professional 2 caregivers 2 patients	1 patient 1 caregiver						

| Data analysis | | | Data base debugging | Database debugging and first analysis | Analysis

Reporting the results | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|

First Wave Piloting

Recruitment of the professionals participating

Description: Professionals involved will be socio-health workers from Association Parkinson Madrid. They will be provided with information about TeNDER project and interested professionals will participate as volunteers.

Location: Madrid. Association Parkinson Madrid Rehabilitation centre. Calle Poeta Esteban Villegas, 12

Professionals involved: 2 professionals (Psychologists)

Participants involved: 14 professionals from Association Parkinson Madrid (1 social worker, 1 psychologist a and 12 therapeutics)

Data collection: Quantitative records of the participants in each group

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Preparation of session´s briefing material			x								
Development of the briefing´s session			x	x							

				7 socio-health professionals	7 socio-health professionals						
Recruitment											

Training activity for professionals participating

Description: The professionals involved will carry two training sessions. The first session will be about the methodology and implementation of TeNDER project and the second one will be about the technological tools and devices to be used by patients, caregivers or involved professionals.

Location: Madrid. Association Parkinson Madrid, Rehabilitation centre Calle Poeta Esteban Villegas, 12. Due to the COVID situation, this training activity will be developed using remote tools (zoom, Rainbow or MSTeams). o keep safe professionals and patients, workers from APM are reducing personal contact.

Professionals involved: 2 APM researchers and 1 UPM technical partner.

Participants involved: Health and social professionals from APM

Data collection: Quantitative record of the participants in each group.

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Constitution of the teaching group			x								
Organization of the course				x							
Preparation of the teaching materials				x							

Development of the training activity					2 sessions in APM venue or by remote tools (COVID-19 situation) 7 professionals involved in each session							
Data analysis					x							

Recruitment of patients and caregivers participating

Description: The professionals involved in TeNDER project will use the Parkinson Madrid database to identify patients and caregivers who meet inclusion criteria. For patients and caregivers agree to participate and being involved will be two appointments One of them to identify the scenario and technology that are suitable to use and assess the devices that can be deploy by technicians. The second appointment will be with the APM researcher to sign the informed consent and perform a personal interview

Location: Madrid. Association Parkinson Madrid rehabilitation centre. Calle Poeta Esteban Villegas, 12. In the case that the COVID-19 situation makes not possible the face to face interview, it will be done by remote tools (Zoom, Rainbow or MS Teams) or by phone.

Professionals involved: 14 socio-health professionals involved, 1 technician from UPM and 4 researchers from APM.

Participants involved: 50 patients (PD) and 50 caregivers. **Data collection:** Quantitative record of the participants in each group and personal interview

	(M10)	**(M11)**	**(M12)**	**(M13)**	**(M14)**	**(M15)**	**(M16)**	**(M17)**	**(M18)**	**(M19)**	**(M20)**

							10 patients and 10 caregivers	10 patients and 10 caregivers	10 patients and 10 caregivers	10 patients and 10 caregivers	10 patients and 10 caregivers	
Recruitment												
Personal interviews							10 patients and 10 caregivers	10 patients and 10 caregivers	10 patients and 10 caregivers	10 patients and 10 caregivers	10 patients and 10 caregivers	
Data analysis									Database debugging	Database debugging	Data analysis	Reporting final results

Using the TeNDER tool

Description: During this phase will be conditioned interviews and direct observation of participants. Reporting about participants, professionals involved and results will be done periodically.

Location: Patients´ homes and rehabilitation centre from Association Parkinson Madrid

Professionals involved: 14 socio-health professionals, 4 APM researchers and 1 technician from UPM.

Participants involved: 50 patients affected by Parkinson´s disease (PD), 50 caregivers and 14 socio-health professionals.

Data collection: Personal interview

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Tender Tool							Report		Report		Report

Personal interview						10 patients and 10 caregivers	10 patients and 10 caregivers	10 patients and 10 caregivers	10 patients and 10 caregivers	10 patients and 10 caregivers	
Data analysis						Database debugging	Database debugging and data analysis	Database debugging	Database debugging and data analysis	Database debugging	data analysis and reporting final results

UNITOV pilot detail											
User Requirements											
Description: Provide the permission of the ethical committee											
Location: University of Rome "Tor Vergata," Department of Biomedicine and Prevention											
Professionals involved: 5 health professionals											
Participants involved: 3 physicians, 2 psychologists											
Data collection: Professionals involved will collect the data required for the ethical and administrative permissions.											
	(M10)	**(M11)**	**(M12)**	**(M13)**	**(M14)**	**(M15)**	**(M16)**	**(M17)**	**(M18)**	**(M19)**	**(M20)**

To provide the necessary permissions and acceptances		X									
Recruit and train the researchers who will perform them	X 3 Physicians			X 2 Psychologists							

First Wave Piloting											

Recruitment of the professionals participating

Description: Professionals involved will give several information sessions about the TeNDER project and interested professionals will register as participants.

Location: Rome, IRCSS Santa Lucia, Department of Neuropsychology

Professionals involved: 11 professionals

Participants involved: 5 physicians, 4 psychologists, 1 administrative employer, 1 nurse

Data collection: Quantitative record of the participants in each group.

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Preparation of session´s briefing material		x									
Development of the briefing's sessions			x								
Recruitment	X 3 physicians			X 2 psychologists		X 2 psychologists					

				2 physicians		1 administrative employer 1 nurse						

Training activity for professionals participating

Description: The professionals involved will carry out 2 training session about the information, implementation and methodology, the TeNDER tools, and devices.

Location: Rome, IRCSS Santa Lucia, Department of Neuropsychology

Professionals involved: 11 professionals

Participants involved: 5 physicians, 4 psychologists, 1 administrative employer, 1 nurse

Data collection: quantitative data analysis

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Constitution of the teaching group	x										
Application for the course			x								
Preparation of teaching materials			x								
Development of the training activity				X 2 training sessions in 1							

					centre/Training test administration									
Data base analysis					Database Debugging	Analysis/Reporting of results								

Recruitment of patients and caregivers participating

Description: The professionals participating will inform patients and caregivers who meet the selection criteria and provide them with informed consent. With those who agree to participate, they will schedule two appointments:

- The first to assess the scenario and the possibility of installing the TeNDER tool.

- The second with the "survey researcher", who will be in charge of carrying out the questionnaires prior to the intervention.

Location: Rome, IRCSS Santa Lucia, Department of Neuropsychology

Professionals involved: 5 physicians, 2 psychologists

Participants involved: 28 patients, 20 caregivers

Data collection: Quantitative record of the participants in each group, Personal interviews.

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Recruitment					X 6 patients, 4	X 22 Patients 16					

						caregi vers	Caregive rs					
Personal interviews						X 6 patien ts, 4 caregi vers	X 22 Patients 16 Caregive rs					
Data base analysis										Data base debuggi ng	analysi s	Report ing of results

Using the TeNDER tool

Description: During this phase will conduct direct observation and personal interview of each participant. Periodically, each institution will make reports indicating: number of participants, professionals involved, results and KPIs.

Location: Homes and hospital

Professionals involved: 5 physicians, 4 psychologists, 1 administrative employer, 1 nurse

Participants involved: 28 patients (AD, PD), 20 caregivers, 11 professionals

Data collection: Personal interviews, Direct observation, communications, and suggestions of users.

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
TeNDER tool							Report		Report		Report
Personal interviews						X 28 patients		X 28 patien			

						, 20 caregivers		ts, 20 caregivers, 11 professionals			
Direct observation						X	x	x			
Data base analysis									X Database debugging	X analysis	X reporting of results

SKBA pilot detail											
User Requirements											

Description: Professionals involved will conduct face-to-face questionnaires and interviews with participants. In case the Alzheimer's Therapy Centre is closed due to Covid-19, questionnaires will be conducted via postal letters.

Location: Alzheimer's Therapy Centre of Schön Klink Bad Aibling

Professionals involved: 2 SKBA researchers

Participants involved: 20 patients, 20 caregivers and 10 social-health professionals

Data collection: Quantitative questionnaires and Qualitative interviews

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)

To provide the necessary permissions and acceptances	X											
Recruit and train the researchers who will perform them	2 SKBA researchers											
Questionnaires: at Alzheimer's Therapy Centre		10 patients 10 caregivers 10 social and health professionals	10 patients 10 caregivers									
Interviews: at Alzheimer's Therapy Centre		2 patients and 2 caregivers 1 professional	1 patient and 1 caregiver 2 professionals									
Data base analysis		Database debugging	Analysis	Reporting of Results								
First Wave Piloting												

 <u>Recruitment of the professionals participating</u>

Description: SKBA researchers involved will give several information sessions about the TeNDER project and interested professionals will register as participants.

Location: Hospital and Alzheimer's Therapy Centre of Schön Klinik Bad Aibling

Professionals involved: 3 SKBA researcher

Participants involved: Health and social professionals; therapeutical professionals; administrative staff of Alzheimer's Therapy Centre

Data collection: Quantitative record of the participants in each group.

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Preparation of session´s briefing material		X									
Development of the briefing's sessions			X	X							
Recruitment			5 professionals	5 professionals							

Training activity for professionals participating

Description: The professionals involved will carry out two training sessions. The first one, about the information, implementation, and methodology of the project. The second one will be to train them in the TeNDER tool and devices.

Location: Hospital and Alzheimer's Therapy Centre of Schön Klinik Bad Aibling

Professionals involved: 3 SKBA researcher

Participants involved: 10

Data collection:

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Constitution of the teaching group	X	X									

Application for the course		X	X									
Preparation of teaching materials			X									
Development of the training activity			X	X								
Training activity			5 professionals	5 professionals								
Data base analysis				X	X							

<u>**Recruitment of patients and caregivers participating**</u>

Description: SKBA researcher will inform patients and caregivers who meet the selection criteria and provide them with informed consent. With those who agree to participate, they will schedule two appointments:

- **The first appointment is (with technical partners?) to assess the scenario and the possibility of installing the TeNDER-tool.**

- **The second appointment is with SKBA researchers, who will be in charge of carrying out the questionnaire prior to the intervention.**

Location: Hospital and Alzheimer's Therapy Centre of Schön Klinik Bad Aibling

Professionals involved: 3 SKBA researchers, (UPM technical partners?)

Participants involved: 32 patients (AD and CVD), 32 caregivers

Data collection: Quantitative record of the participants in each group, personal interviews

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Recruitment						8 patients and 8 caregivers	8 patients and 8 caregivers	8 patients and 8 caregivers	8 patients and 8 caregivers		
Personal interviews						8 patients and 8 caregivers	8 patients and 8 caregivers	8 patients and 8 caregivers	8 patients and 8 caregivers		
Data base analysis								Database debugging	Database debugging	Analysis	Reporting of results

Using the TeNDER tool

Description: During this phase, we will conduct personal interviews of each participant. Periodically, each institution will make reports indicating: number of participants, professionals involved, results and KPIs.

Location: Hospital and Alzheimer's Therapy Centre of Schön Klinik Bad Aibling

Professionals involved: 3 SKBA researcher, UPM technical partners

Participants involved: 32 patients (AD and CVD?), 32 caregivers, 10 social and health professionals and administrative personnel

Data collection: Personal interviews

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
TeNDER tool							Report		Report		Report
Personal interviews						8 patients and 8 caregivers	8 patients and 8 caregivers	8 patients and 8 caregivers	8 patients and 8 caregivers	5 professionals	5 professionals
Data base analysis									Database debugging	Analysis	Reporting of results

SPO pilot detail

User Requirements

Description: The researches involved will conduct the questionnaires and interviews with the participants face-to-face or by phone; the participants will fill in the questionnaires on the Spominčica internet page

Location: Spominčica centre, Spominčica internet page

Professionals involved: 4 social professionals

Participants involved: 20 patients, 20 caregivers, 10 professionals

Data collection: quantitative questionnaires, qualitative interviews

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
To provide the necessary permissions and acceptances											
Recruit and train the researchers who will perform the interviews	2 soc. prof.	2 soc. prof.									
Questionnaires: on the Spominčica internet page and face-to-face at Spominčica centre		5patients, 5 caregivers, 1 professional	5 patients, 5 caregivers, 3 professionals	10 patients, 10 caregivers, 6 professionals							
Interviews: at Spominčica centre		3	3 professionals	3 patients, 3 caregivers							
Data base analysis			Data base debugging	Analysis	Reporting of results						
First Wave Piloting											
Recruitment of the professionals participating											

Description: Professionals involved will give several information sessions about the TeNDER project and interested professionals will also have an option to register as the participants.

Location: Spominčica centre, Alzheimer cafes

Professionals involved: 4 social workers, 3 SPO researchers

Participants involved: 10**,** Health and social professionals, and day care centre management staff

Data collection: Quantitative data for each group

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Preparation of session´s briefing material		X									
Development of the briefing's sessions			X	X							
Recruitment			3 professionals	7 professionals							

Training activity for professionals participating

Description: The professionals involved will carry out two training sessions. The first one, about the information, implementation,, and methodology of the project. The second one will be to train them in the TeNDER tool and devices.

Location: Spominčica centre, day care centres

Professionals involved: 4 social workers, 3 SPO researchers

Participants involved: Health and social professionals, and day care centre management staff (10)

Data collection: quantitative data, qualitative semi-structured interview

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
Constitution of the teaching group	X	X									
Application for the course		X	X								
Preparation of teaching materials			X								
Development of the training activity			X	X							
Training activity				5 prof.	5 prof.						
Data base analysis				X	X						

Recruitment of patients and caregivers participating

Description: The professionals participating will inform patients and caregivers who meet the selection criteria and provide them with informed consent. With those who agree to participate, they will schedule two appointments:

- The first to assess the scenario and the possibility of installing the TeNDER tool. This will be accompanied also by technical partners.

- The second with the "survey researcher", who will be in charge of carrying out the questionnaires prior and after the intervention.

Location: Spominčica centre, day care centres, Alzheimer cafes

Professionals involved: 4 social workers, 1 health professional, 3 SPO researchers, technical partners

Participants involved: 30-40 patients, 20-30 caregivers

Data collection: Quantitative for each participant group

Recruitment						≥ 6 patients, ≥3 caregivers	≥ 6 patients, ≥3 caregivers	≥ 6 patients, ≥3 caregivers	≥ 6 patients, ≥3 caregivers		
Data base analysis								X	X	X	Reports

Using the TeNDER tool

Description: During this phase we will conduct personal interview with participants. Periodically, we will make reports indicating: number of participants, professionals involved, results.

Location: Patients homes, Spominčica centre and day care centres

Professionals involved: 4 social workers, 1 health professional, 3 SPO researchers, technical partners

Participants involved: 8 professionals, 30-40 patients, 20-30 caregivers

Data collection: Quantitative for each participant group and Qualitative: interviews

	(M10)	(M11)	(M12)	(M13)	(M14)	(M15)	(M16)	(M17)	(M18)	(M19)	(M20)
TeNDER tool							Report		Report		Report
Personal interviews						≥ 6 patients, ≥3 caregivers	≥ 6 patients, ≥3 caregivers	≥ 6 patients, ≥3 caregivers	≥ 6 patients, ≥3 caregivers	≥ 6 patients, ≥3 caregivers, 4 prof.	≥ 6 patients, ≥3 caregivers, 4 prof.
Data base analysis									X	X	X

4. Architecture Blueprint

This section will go through all the relevant aspects for the proposed architecture of the project. The methodology top-down has been followed to properly define the most optimal solution from both, logical and technical points of view.

4.1. Technical Architecture Overview

Service Oriented Architecture (SOA) will be implemented in the development of the platform. Each element must work individually and must interact with other modules as services through interface layers.

TeNDER may be divided in six different structures as described in the image below; client's interface – visual independence (e.g. Home Set, patients TV, Caregivers Mobile, Professionals Web Interface), services, high- and low-level subsystems and data repositories.
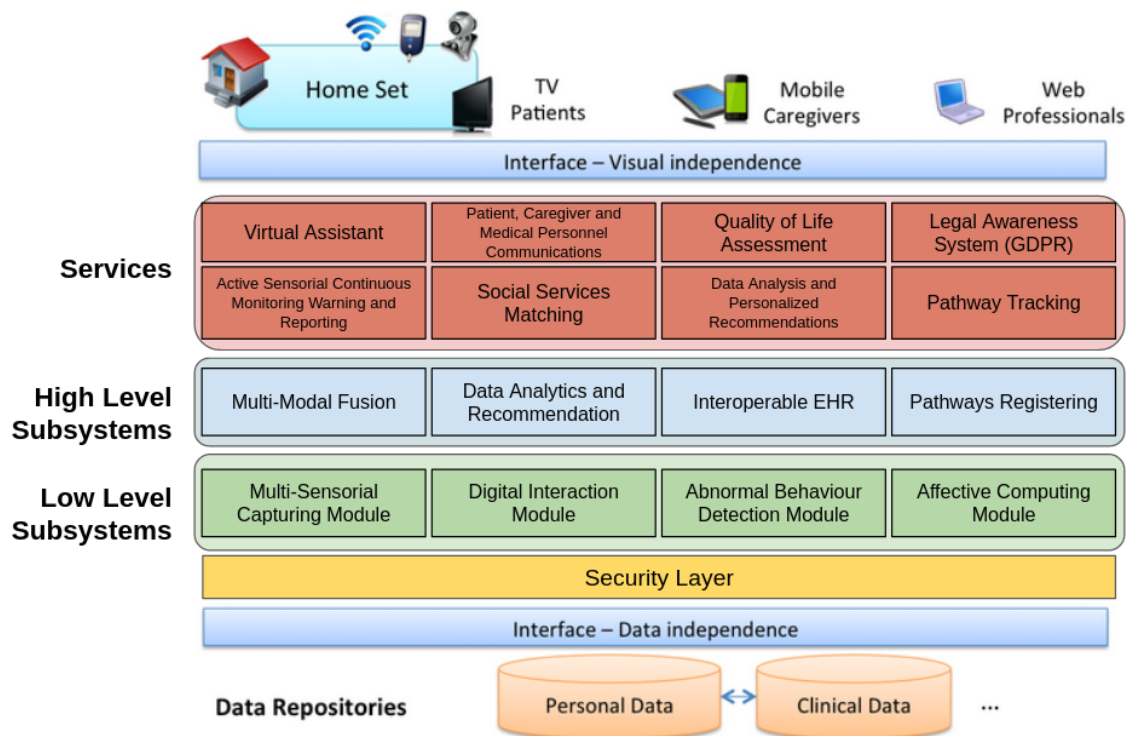

Figure 9 TeNDER Architecture

Two servers can be distinguished in this graph (Figure 1) with at least two or more databases of different nature (relational or non-relational databases). On the one hand, a server that collects and

serves data information related to patients' data-oriented services (represented in the chart as Services).

On the other hand, a server that will work with data coming from sensors and will model somehow patients' state (represented in the chart as high- and low-level subsystems).

As stated in the TeNDER Description of Action (DOA) and the previously defined scenarios, there are three main layers to provide the TeNDER services, the Low-Level Subsystems (LLS), the High-Level Subsystems (HLS) and the TeNDER Services.
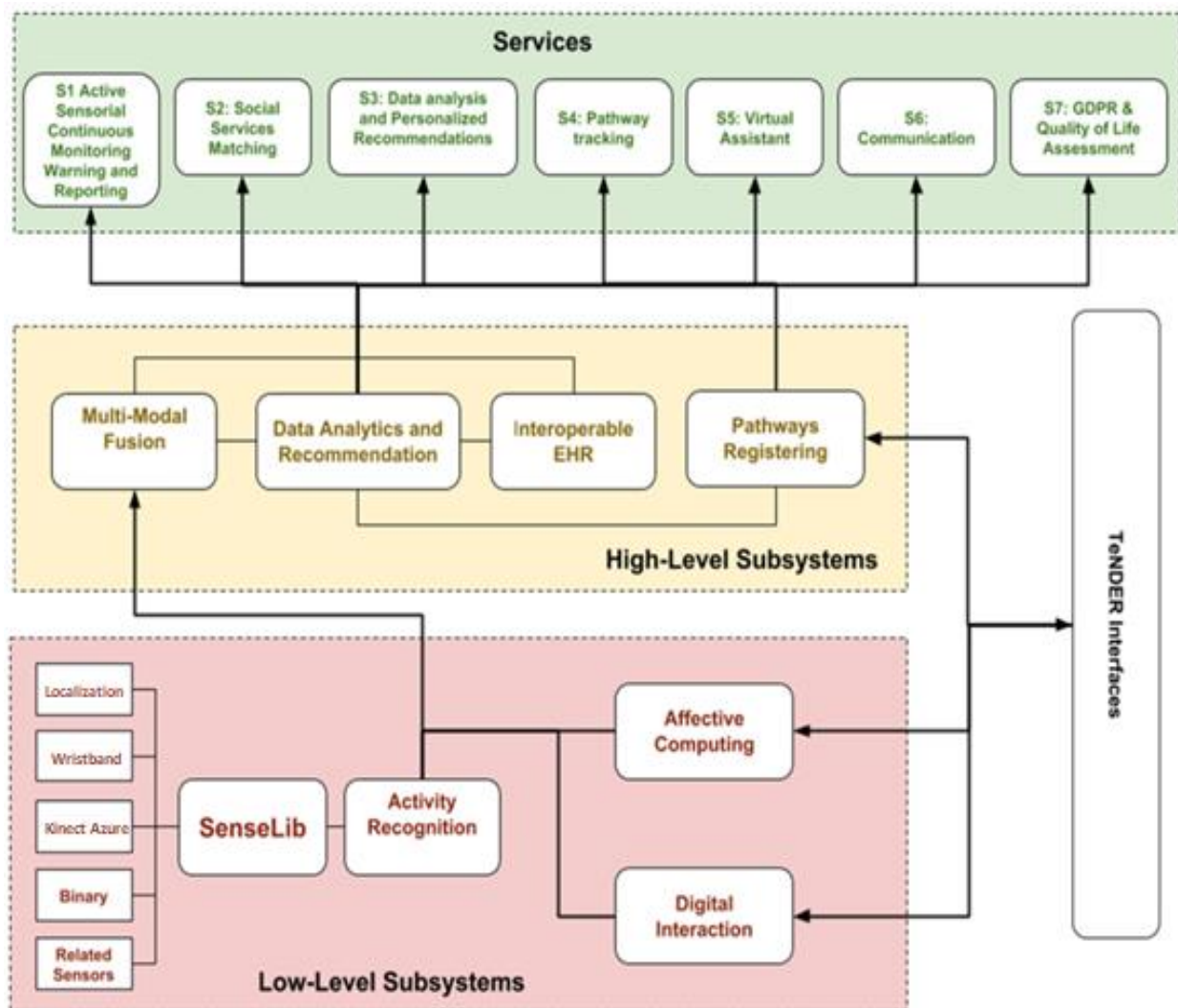

Figure 10 TeNDER System Architecture

The Low-level Subsystem will be in charge of gathering information from different sources. his layer is physical based and therefore will be located at the TeNDER aforementioned scenarios. This subsystem

will cover the sensor deployment and the communication between different devices. Therefore, a backend management module will handle data collection, health tracking and abnormal event detection.

Both Services and High-level subsystems will be located at different servers than the Low-level Subsystems will be to guarantee optimal data security and comply with the ethical guidelines of the project.

The TeNDER architecture will consider the centralized development of the High-level subsystem and services implementation. This architecture will ensure scalability of the system allowing the integration of future nodes.

Finally, data will travel between different components of the system in a secure manner by placing in order different security mechanism to provide a transparent and safe transmission of data that can be considered personal such as health data. The main idea behind TeNDER to provide a 100% personal data protection is that personal data will be processed only locally and will never be transmitted as such for further processing on the cloud or in other (of site) premises. An initial TeNDER dataflow can be seen in Figure 3:
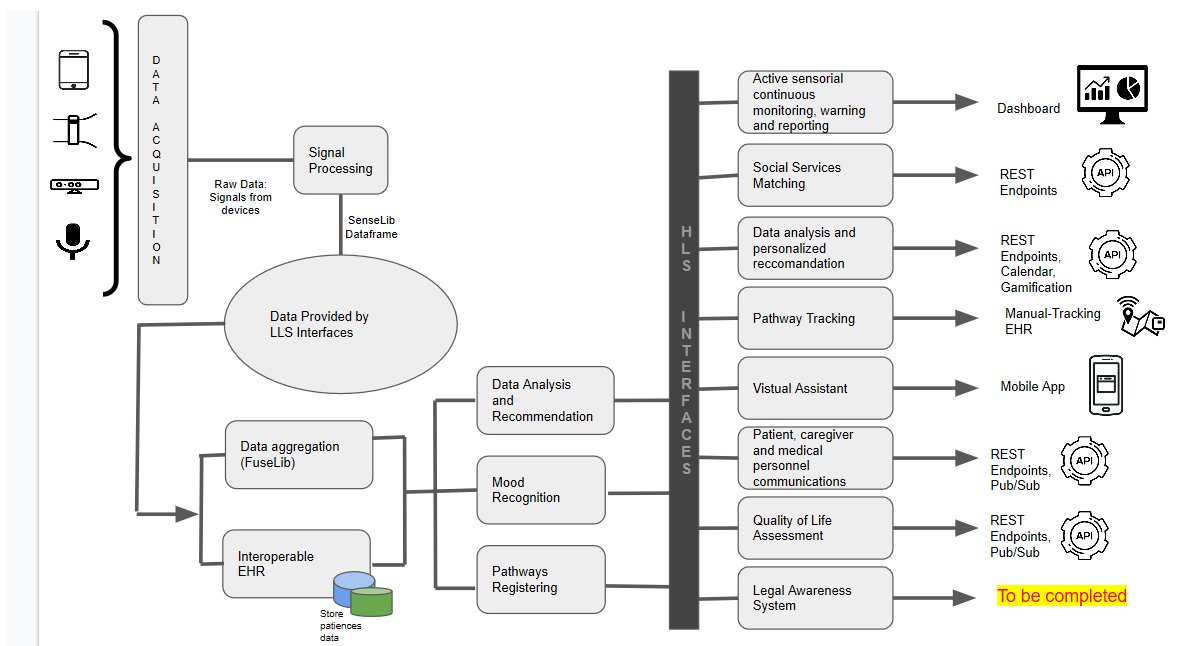

Figure 11 TeNDER First draft of Dataflow

4.2. Low-level Subsystem

The low-level subsystem (LLS) is composed by several sensing modules that will gather information from the patients. These modules are divided into several categories (all the modules will work independently, and the ones desired for the same aim will be able to combine their performance to optimize the results, but also to work on their own). OBJ The following is short presentation of the HeTra subsystem and its components, as well as of all the independent modules of the LLS.

HeTra subsystem is the core subsystem that enables tracking patient variables and will offer to the low- and high-level subsystem's modules the functionality to track specific health characteristics, from direct health situation information to periodical test results and feedback from professionals. This subsystem will: 1. Enable users (medical doctors and caregivers) to choose which health characteristics to track and 2. Provide an efficient feedback mechanism that, along with user activity recognition and, through multimodal fusion, will allow for the extraction of valuable conclusions regarding health status.

HeTra will be responsible for the data acquisition from the sensors (Kinect Azure, Wristband, Localization Tracker, Sleep Tracker, Voice Tracker, Pill Dispenser, Binary Sensors). As illustrated in Figure 4, HeTra will deliver the acquired data to the Abnormal Behaviour Detector (ABD) subsystem that is part of TeNDER LLS and to the Multimodal Fusion (MMF) subsystem which is part of the HLS.

HeTra will not just deliver raw data as acquired from the sensors but it will also analyse them to extract features that will be useful for subsequent analysis. This analysis will be performed in SENSELib. This library will include sensor data acquisition tools as well as specific algorithms for an initial data processing (tracking, skeleton smoothing, dimensionality reduction etc.).
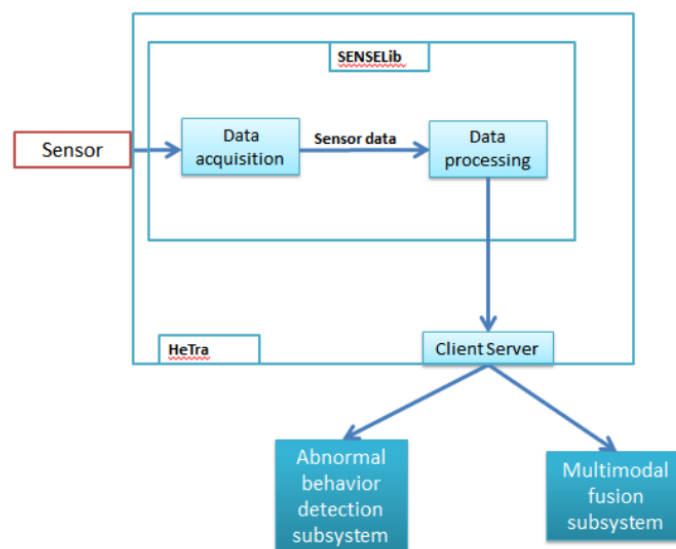

Figure 12. SenseLib schematic description.

A client of HeTra will run on the other subsystems of TeNDER (ABD and MMF subsystems) through which the communication with HeTra will take place.

SENSELib will be part of the TeNDER's open API system and will be used to develop HeTra subsystem. This library will provide two types of functionalities, i.e., acquisition and processing ones (Figure 5). HeTra subsystem will be able to get and deliver both unprocessed and processed data.
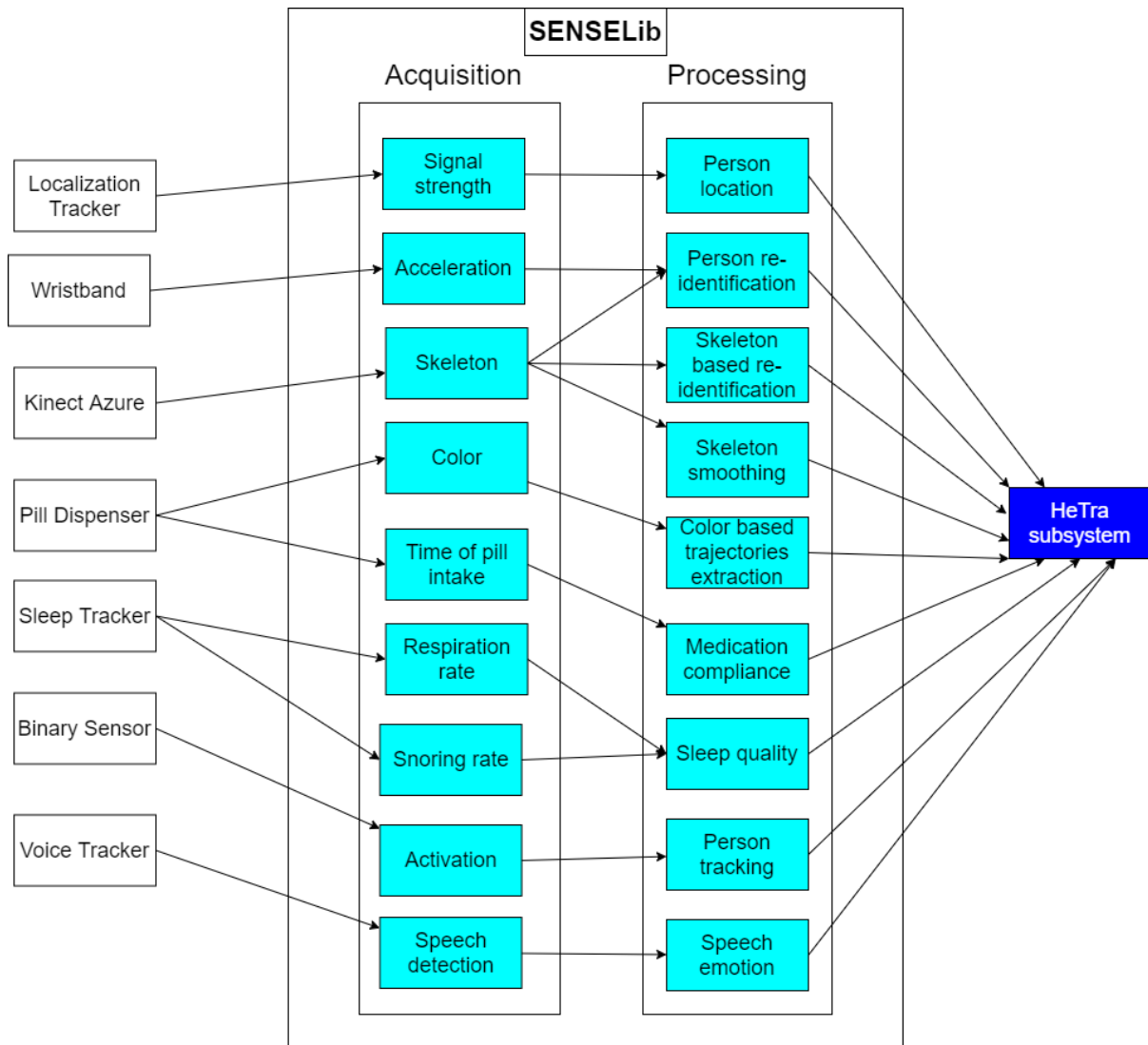

Figure 13 . SENSELib Schema workflow

SENSELib modules and their Technical specifications (HW/SW) are presented following.

1. **Multi-Sensorial Capturing module:** Core module to enable tracking patient variables and to offer the service modules the functionality to track specific health characteristics, from direct health situation information to periodical test results and feedback from professionals. Example: Parkinson's patients' daily activities will be correlated to medication they receive and the system should be able to evaluate its impact on their daily routines. Dementia, AAlzheimer's, and Parkinson's health plans will be analysed and defined during the project to select the homologated scales to use in the tracking the personal status. There are scales for quality of life, dependence, stress, general health level, etc. that will need to be selected together with the clinical and social team in the first stages of the project.

2. **Digital Interaction Module:** With the objective of having a personalized platform that can adapt its behaviour to patient condition and interaction with the TeNDER platform and its services, TeNDER will design and develop an interaction tracking system that analyses patient access to the different interfaces and their behaviour when using the platform in any of the interfaces. This digital behaviour analysis will help the platform to identify recommendations and help the user (patient, caregiver, professional), by analysing her/his knowledgeability on her/his condition and the treatment or processes that need to be followed.

3. **Abnormal Behaviour Detection module:** This module will focus on analysing sensing information to identify behaviour and inform any interested party (professionals, formal/informal caregivers) about the patient's situation. Exploiting intelligent capabilities of an indoors activity recognition methodology, employing ambient and depth sensors, environmental sensors and mobile based sensors, this core subsystem will provide the TeNDER ecosystem with the capability of assessing on the real deviations from the expected daily conduct of the person (e.g. the senior missed to take a medication dose) and any (previously parameterized) human abnormal behaviour (e.g. for Parkinson's patients need to be controlled if the patient gets blocked or has fallen to help the patient or warn the caregivers)

4. **Affective Computing module:** This module will apply advanced deep learning and Computer Vision techniques to extract relevant features (i.e. general, facial, speech or behavioural) that can allow to estimate the expression and mood of patients. This information will be extracted by using the smartphone devices and will be used as input to up-level services that will support the patient.

5. **Localization tracking module:** This module will combine the information gathered from different sensing devices deployed across the areas to be monitored (For TeNDER purposes, it will be deployed in all scenarios) through a wireless sensor network. Static binary sensors will send information about the interaction with the environment (door open/closed). Wristband device will send health information such as pulse rate and temperature. Moreover, additional information about the position of the participants can be extracted from the wristband looking at the RSSI (Received Signal Strength Indicator). Main technologies that will be employed involve Localization hardware devices. As a result of these techniques a continuous time-real room-level tracking will be reached.

6. **Kinect Azure tracking module:** Kinect Azure sensor will be used for person tracking (to monitor the person's movements and body position). Kinect Azure SDK contains a skeleton tracking based on the fusion between RGB information and depth information, there by more accurate in detecting body joints positions and more robust in difficult conditions like change of lights.

Kinect Azure sensors will be deployed in all the scenarios: In home scenario and in Daily centre scenario it will be placed in an elevated position (e.g. above a closet) to amplify the recording area. In the rehabilitation centre the sensor will be placed in front of the subject to better register the change of movement during the exercises.

4.2.1. Modules Description

Kinect Tracking module	Description
Functionalities	Retrieve process and deliver rich sensor data (SENSELib & HeTra low level subsystems). The Kinect tracking module will deliver highly accurate body trajectories, de-noised through a novel filtering procedure. Moreover, tracking will provide re-identification functionalities to correlate trajectories to specific patients.
Implemented on	SENSELib
Interfaces Exposed (Outputs)	The HeTra API will enable other subsystems to request and get low level data from sensors. SENSELib will be responsible for the data acquisition from the sensors and their pre-processing to extract features that will be sent through HeTra to Abnormal Behaviour Detection and Multimodal Fusion subsystems.
Interfaces Requested (Inputs)	Wired (USB 3) connection with Kinect as well as the Sensor APIs.
Algorithms employed	Kalman and Kalman/Tobit filtering will be used to filter the acquired skeletons and to decrease the estimation errors.
Instances and Deployment	Depending on each specific use case the hardware deployment will be such, to maximize the possibility to track the patients in their daytime activities.

Programming languages	C#/C++
Libraries	Standard open libraries for video and image processing (e.g., OpenCV)
Issues & Notes	Kinect cameras will operate ~17-19 hours per day. In practice, they will stop working for 5-7 hours every night (in a predefined time interval) in which the patient is sleeping.

Table 5. Kinect Tracking module

Within the TeNDER, it is agreed that Kinect Azure sensors will be used for depth sensing. The specifications for the use of these sensors are the followings:

Each Kinect Azure sensor requires a PC with the following (minimum) specifications:

- Seventh Gen Intel® CoreTM i3 Processor (Dual Core 2.4 GHz with HD620 GPU or faster)

- 4 GB Memory

- Dedicated USB3 port

- Graphics driver support for OpenGL 4.4 or DirectX 11.0

- Windows 8 or 8.1, Windows Embedded 8, or Windows 10

Sleep Tracking module	**It collects users' sleep data using a Sleep tracking mat which is located under the user's mattress.**
Functionalities	It monitors the quality of sleep (duration, sleep state, respiratory rate, heart rate, snoring).
Implemented on	SENSELib
Interfaces Exposed (Outputs)	API link: https://rr.intectiv.si:10004/sleep-tracker/?SensorID=20801444

Interfaces Requested (Inputs)	Withing's sleep tracker sensor API link: https://developer.withings.com/oauth2/
Algorithms employed	Averaging the heart rate data on data frames. Other data is as it is obtained from Withing's Cloud.
Instances and Deployment	The sensor will be installed under the user's mattress and connecting it to the local Wi-Fi as described in the sensor manual. After that, the (virtual) user registration on Withing's is required and allowing the TeNDER application to gather the sleep data.
Programming languages	Python, C#
Libraries	Falcon
Issues & Notes	The Withing's API makes data available after the user wakes up.

Table 6. Sleep tracking module

Localisation Tracking module	**It monitors the strength of the signal from the wristbands or other Bluetooth(r) tags worn by the users and determines the room-level position.**
Functionalities	Identify probable causes of insomnia and check behaviour and position status of the patient.
Implemented on	SENSELib
Interfaces Exposed (Outputs)	API link: https://rr.intectiv.si:10004/position-tracker/?SensorID=30AEA412C380&mac=CAEB0DCFF147
Interfaces Requested (Inputs)	MQTT protocol with JSON
Algorithms employed	Max signal of all the devices that sees the specific device. This represents the room where the user is currently located.

Instances and Deployment	The scanners are positioned in each room we want to localize a user (preferably as far apart as possible to increase accuracy). After plugging the scanner to the wall outlet, it can be connected to the local Wi-Fi.
Programming languages	Python, C#
Libraries	Falcon
Issues & Notes	

Table 7 Localisation Tracking module

Pill dispenser module	**It notifies the patient to take a medication on a predefined schedule.**
Functionalities	Medication intake monitoring and check behaviour and position status of the patient.
Implemented on	SENSELib
Interfaces Exposed (Outputs)	API link: https://rr.intectiv.si:10004/pill/?device_id=XXXXXXXXXX
Interfaces Requested (Inputs)	/
Algorithms employed	/
Instances and Deployment	The pill dispenser must be filled with medication and the intake schedule should be defined. The pill dispenser must be connected to the main power.
Programming languages	Python, C#
Libraries	Falcon

Issues & Notes	

Table 8 Pill dispenser module.

Wristband module	**Description. Used to extract the biological information from the patient such as heart rate and SPO2. Additionally, using the onboard inertial measurements provided by the accelerometer, it provides information to perform the re-id.**
Functionalities	To identify probable causes of insomnia. Emotional state detection. Hours of deep sleep, hours of light sleep, Nº of night awakenings. Accelerometer for re-identification.
Implemented on	Android app for data extraction and HTTPS API for data collection and ingestion in HeTRA and the HLS.
Interfaces Exposed (Outputs)	None
Interfaces Requested (Inputs)	None
Algorithms employed	N/A
Instances and Deployment	HTTPS secure server implemented at UPM.
Programming languages	Android, Python.
Libraries	Flask.
Issues & Notes	

Voice Tracker module	Description
Functionalities	Emotional state detection
Implemented on	SENSELib
Interfaces Exposed (Outputs)	JSON file sharing
Interfaces Requested (Inputs)	Mic Audio flow
Algorithms employed	Deep Learning algorithm that makes use of a convolutional neural network (CNN) composed of three layers: Input layer (Dense layer 256); Hidden layer; Output Layer.
Instances and Deployment	The speaker is connected to a pcbox in local and it is powered through USB. There are no additional requirements for the installation of the system.
Programming languages	Python
Libraries	TensorFlow, end-to-end open source platform for machine learning
Issues & Notes	/

Table 9. Voice tracker Module
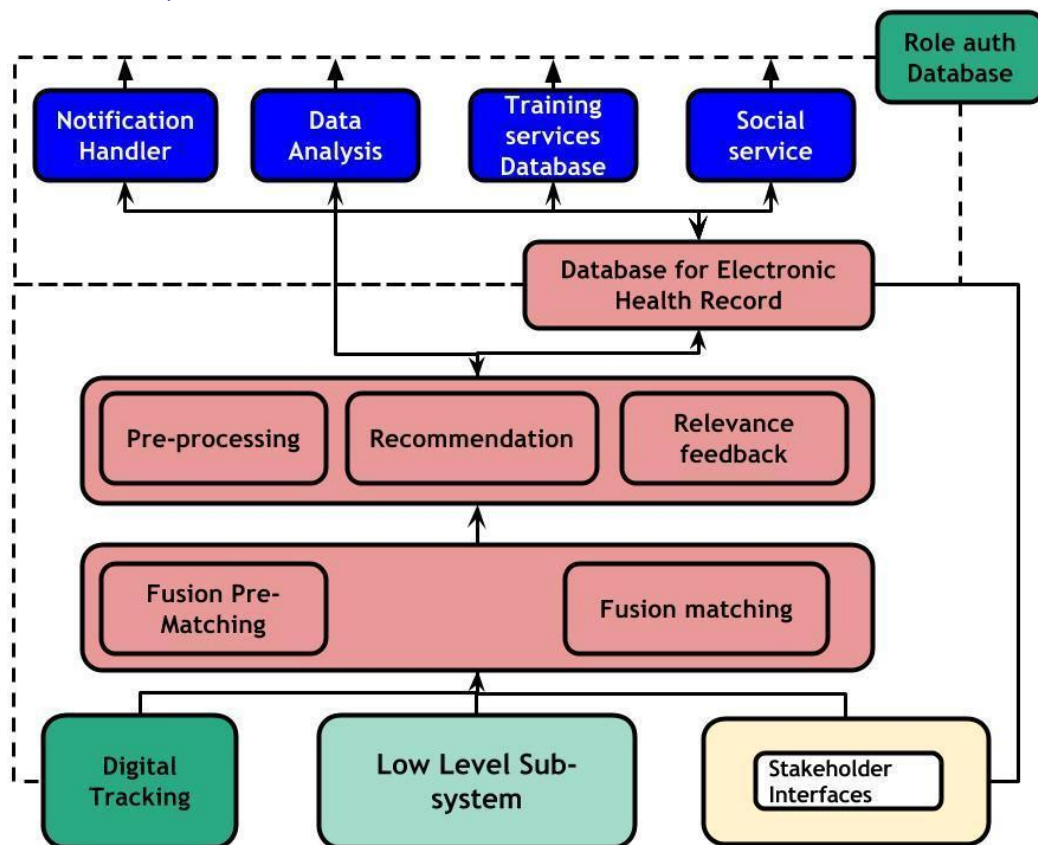
4.3. High Level Subsystem

Figure 14 High-Level subsystem

4.4. Services.

TeNDER aims at providing a toolbox of services tackling the main variables (from clinical, social,, and quotidian views) that affect patients to improve their QoL and better involve the HealthCare actors as follows:

Services will utilize the information generated through the TeNDER ecosystem to generate information to the related stakeholders as depicted in Figure 7. Specifically, TeNDER has created a set of seven Clusters of Services that, using the core technologies of the system, to serve a plethora of ways in which senior citizens, living on their own, affected by any of several of the Chronic Diseases, are expected to be supported.
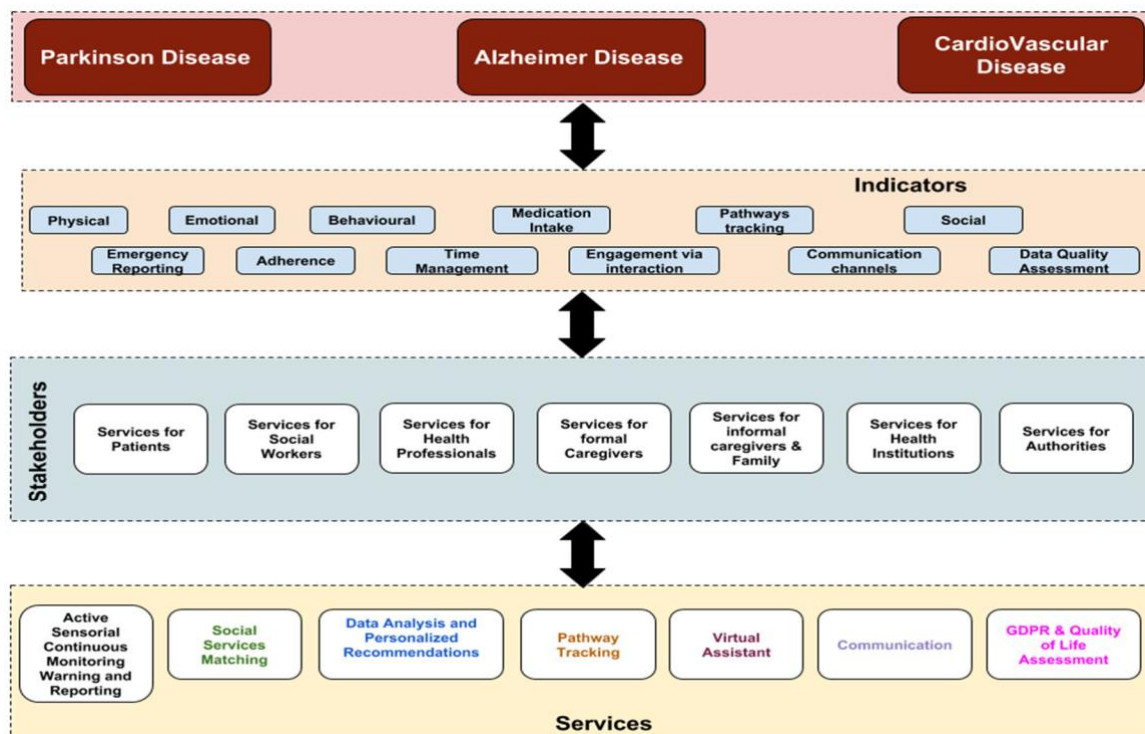
Figure 15 TeNDER Services, Stakeholders, indicators for the Chronic Diseases covered

TeNDER services server has exposed an API that allows users to access to the different modules provided. Access will be provided in a secure way via authorized roles.

At the same time, it will expose another secure API where sensors and remote computers will be connected to a central server (TeNDER cloud). All requests will have a valid token previously generated by the login services. A task is in charge of gathering all the services available in the platform. A set of sub-models will be defined to achieve all users' requirements.

Here follows an initial approach of two UML use case diagrams that correspond to two examples of the User Stories in Section 2 [document TeNDER_All_User_Story].

For example, in Figure 8 a UML use case diagram is depicted according to the use case scenario (as described in the Section 2 [document TeNDER_All_User_Story Table 2)], in which a patient who suffers from Parkinson's Disease is monitored in his/her house.

Another instance of a UML use case diagram is shown in Figure 9. In this case, the patient suffers from Alzheimer and he/she is located in Day-Care Centre (as described in the Section 2 [uploaded document TeNDER_All_User_Story, Table 4)].

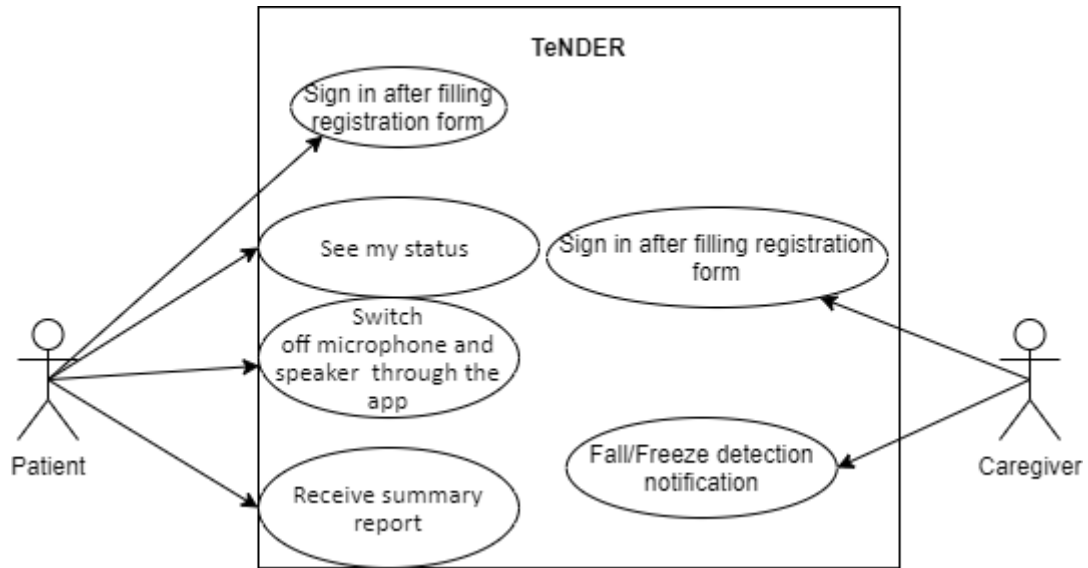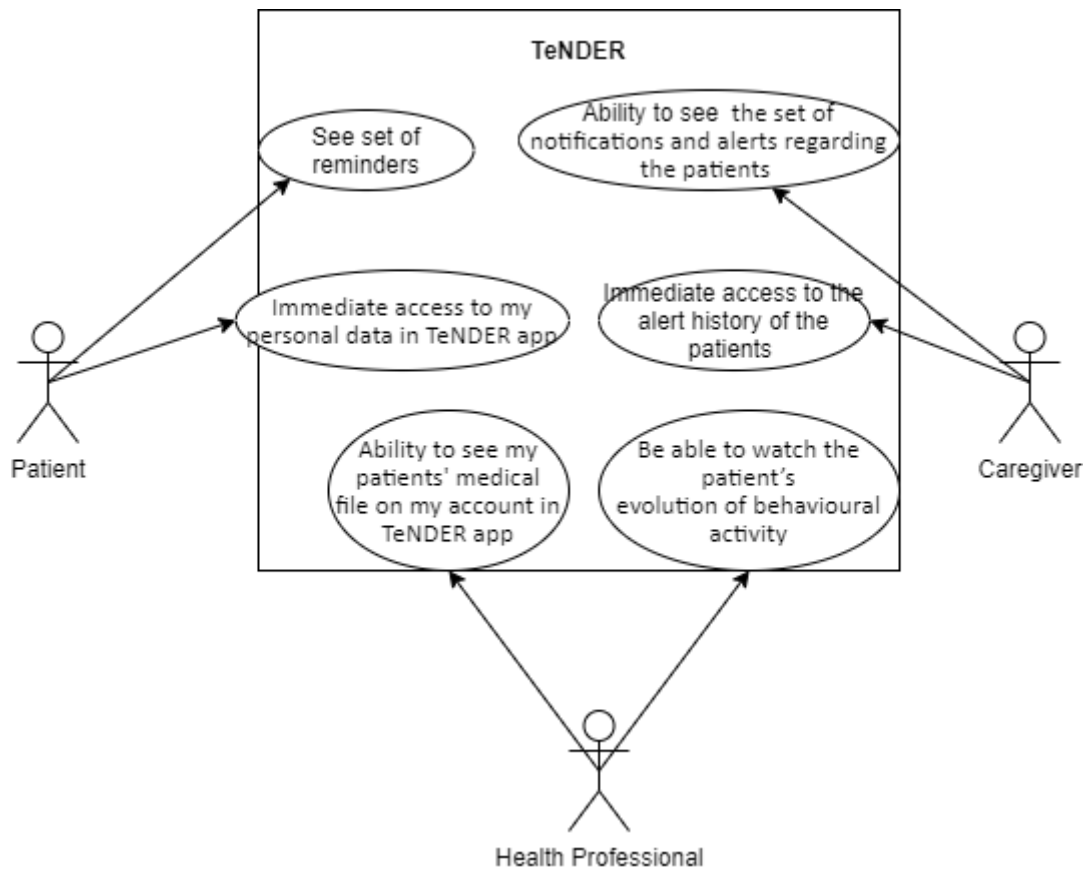*Figure 16 . TeNDER UML Table 2 HOME SET Parkinson Disease*

Figure 17 TeNDER UML Table 4 Day-Care CENTER Alzheimer or related

4.4.1. Service Cluster 1: Active Sensorial Continuous Monitoring, Warning and Reporting.

This system will take advantage of the use of multi-sensorial infrastructure to provide patients with:

- **Health tracking service:** This service will offer patients the monitoring of patient biological, behavioural variables such as blood pressure, weight; reaction to stimulus; Social behaviour (among others). The service will be in charge of capturing relevant data from the patient and his/her environment to detect abnormal situations.
- **Emotional/affective detection service:** this service will be end-user oriented and intends to detect the patient's mood to support their status enabling services that might help him in case of negative feelings (i.e. sadness, depression-like).
- **Warning and reporting service:** this service will be in charge of controlling the patient variables and report any special/abnormal event to the adequate stakeholder (caregiver, informal caregiver, and family) according to the type of event, the relevancy and the action required (i.e. to call emergency services)

Service Cluster 1	Description
Functionalities	Services responsible of providing patients with Health Tracking, Emotional/Affective detection,, and Warning/Reporting Services
Implemented on	TeNDER Services
Interfaces Exposed (Outputs)	Front End applications
Interfaces Requested (Inputs)	Available TeNDER sensors, Recommendation System
Algorithms employed	N/A
Instances and Deployment	

Programming languages	
Libraries	
Issues & Notes	

Table 10 . Service Cluster 1

4.4.2. Service Cluster 2: Social Services Matching.

This set of services is devoted to bring the social supply to the patients. The ambition is to integrate medication, medication intake, exercises, nutrition, and non-medical assistance functionalities (daily routines, from cleaning to administration, shopping, occasional travel, or basic finances like paying bills) and related monitoring into connected modules which local caregivers can access and make decisions/provide support services.

- Patients can select/obtain services and type of assistance from a list available locally or have information about the type of assistance provided or available. They can follow their own status and wellbeing, getting suggestions/instructions about nutrition or exercise.
- Caregivers can use monitoring data and user requirement information to analyse situation and start/adjust the level of support and select trained staff to provide assistance. They can monitor patients' TeNDER Sections 1-3 Page 12 of 70 adherence to previously agreed activities (from exercises to medication or taking adequate nutrients, vitamins, etc.).
- Feedback from monitoring or change in available services may lead to modification of level of support.
- Medical information (from other subsystems) may also assist to set the adequate level and combination of support services.
- The services will be provided to users, caregivers (formal or informal), family and social worker (and institutions).

Service Cluster 2	Description
Functionalities	This cluster of services is in charge of bringing social supply to the patients.
Implemented on	TeNDER Services

Interfaces Exposed (Outputs)	TeNDER services Rest Endpoint
Interfaces Requested (Inputs)	Recommendation System, Monitoring, Medical Information from other subsystems
Algorithms employed	N/A
Instances and Deployment	
Programming languages	
Libraries	
Issues & Notes	

Table 11 Service Cluster 2

4.4.3. Service Cluster 3: Data Analysis and Personalized Recommendations

Professional oriented service to offer value on the patient data gathered through different services and through the analysis of the interaction amongst all the involved parties. The objective will be to generate knowledge by a continuous data analysis focus on all patients' information identifying patterns and models of best practices in coordination, treatment, recommendations offered, gamification integration, interaction design, etc. Knowledge will be offered to medical and social professionals while using platform services with information on alternatives used by other professionals of the platform in the actions they are taking.

- Follow-up protocols: Chronic conditions need follow up protocols to understand their evolution and patient's specific needs at all stages. This service will automatically recommend forms and questionnaires to identify patient situation, while recommendations will also be targeted to caregivers that take care of patients on a daily basis. The service will include different protocols depending on the disease of the patient and will be open to new protocols when future targets are incorporated into the platform.

Service Cluster 3	Description
Functionalities	Knowledge generation and sharing with medical and social professionals
Implemented on	TeNDER Services
Interfaces Exposed (Outputs)	TeNDER Services: Rest Endpoint, Calendar, Gamification
Interfaces Requested (Inputs)	TeNDER Services: Training, Calendar TeNDER EHR
Algorithms employed	N/A
Instances and Deployment	Web Application developed with Spring Java framework deployed into Web server
Programming languages	Java, SQL
Libraries	>= Java 1.7, Spring Core, Spring MVC, Spring Data
Issues & Notes	

Table 12 Service Cluster 3

4.4.4. Service Cluster 4: Pathway Tracking

This service employs all data flow across the System and will analyse the patient non-clinical activity, providing all stakeholders with relevant information to optimize time management in the patient healthcare chain.

- Clerical Pathway: using all information available, this service will register the entire repository of events associated to healthcare attention to the patient. The ambition of this service is that

the data of the patient clerical activities (i.e. visit to primary attention, visits to the neurologist, GPs, among others) could be available ubiquitously to all health-related institutions.

● Quality of data provided: This service will enable TeNDER to improve continuously in the manner that information is retrieved and presented to health professionals. This service therefore, will define the mechanisms to have a continuous feedback on the quality (usefulness) of recommendations, graphs, evolutions, and inferences to attain the optimal efficiency of the system.

Service Cluster 4	Description
Functionalities	Employ all data flow across the System, analyse the patient non-clinical activity and provide stakeholders with information relevant with optimising time management in the patient healthcare chain
Implemented on	TeNDER Services
Interfaces Exposed (Outputs)	TeNDER Services: Manual-Tracking TeNDER EHR
Interfaces Requested (Inputs)	TeNDER Services: Rest Endpoint, Calendar, Gamification
Algorithms employed	N/A
Instances and Deployment	Web Application developed with Spring Java framework deployed into Web server
Programming languages	Java, SQL
Libraries	>= Java 1.7, Spring Core, Spring MVC, Spring Data
Issues & Notes	

Table 13. Service Cluster 4

4.4.5. Service Cluster 5: Virtual Assistant

This service will collect general information, through TeNDER interfaces, specially from patients and carers to:

- Reminder services: General information about appointments, medication intake, there will be two kinds of reminders: medication administration and medical appointment. In this way, this service will be a key for the treatment adherence objectives in the project. The reminders will be depicted in the user interface screens (TV set and smartphone) in a graphical and synchronized manner.
- Matching services: the needs and skills matching services will be one of the core available components that will support patients, careers, and social workers to guide the patients to find their best fit in accordance to their needs, as well as offering the best habits to engage them into an active social life and healthy empowerment.

Service Cluster 5	Description
Functionalities	This service cluster is in charge of collecting general information through TeNDER interfaces
Implemented on	TeNDER Services
Interfaces Exposed (Outputs)	User Interface Screens
Interfaces Requested (Inputs)	TeNDER Services : Person, Parses TeNDER HER
Algorithms employed	N/A
Instances and Deployment	Web Application developed with Spring Java framework deployed into Web server
Programming languages	Java, SQL
Libraries	>= Java 1.7, Spring Core, Spring MVC, Spring Data

Issues & Notes	

Table 14. Service Cluster 5

4.4.6. Service Cluster 6: Patient, Caregiver and Medical personnel Communications

Service to offer social communication among users of the Platform at different privacy levels and with different objectives:

- Family Support: Communication among family members, caregivers, and patients to reduce patient loneliness and to offer personal services for the patient.
- Social Interaction: Among patients with similar situations to motivate patients with socialization.
- Care Support: Communication between professionals and caregivers or patients.
- Coordination: Foster coordination among medical and social professionals.
- Share Knowledge: Communication among professionals to share treatment knowledge and best practices.

Service Cluster 6	Description
Functionalities	Offers social communication among platform users at various privacy levels and with different objectives
Implemented on	TeNDER Services
Interfaces Exposed (Outputs)	TeNDER Services: Rest Endpoint, Pub/Sub
Interfaces Requested (Inputs)	TeNDER Services: Calendar, Gamification
Algorithms employed	N/A

Instances and Deployment	Cron applications written in Python, REST API written in Python, Ngnix inverse proxy for redirect inbound request to Rest API, Redis database.
Programming languages	Python
Libraries	>= Python 2.7, boto3 (1.2.3), falcon (0.3.0), futures (3.0.3), gunicorn (19.4.5), pycrypto (2.6.1), pymongo (3.2.2), PyYAML (3.10), redis (2.10.5), requests (1.2.3), rsa (3.3), simplejson (3.6.5)
Issues & Notes	

Table 15. Service Cluster 6

4.4.7. Service Cluster 7: Quality of Life Assessment

This service will allow users to measure and know the impact of their communications via TeNDER channels. Additionally, this service will allow to match questionnaires related to QoL (i.e. SF-36, SF-12, OP-QoL, PDQ8, PDQ39 or QoL-AD) in an interactive manner by using interface dynamic tools and serious games.

Service Cluster 7	Description
Functionalities	TeNDER will try to encourage users in the user of the application using games throughout the system experience. This service will record actions rules to calculate points, achievements, and rewards.
Implemented on	TeNDER Services
Interfaces Exposed (Outputs)	TeNDER Services: Rest Endpoint, Pub/Sub, Notification via Pub/sub

Interfaces Requested (Inputs)	TeNDER Services: Documents Calendar, Training, Manual-Tracking, and Person. TeNDER EHR
Algorithms employed	N/A
Instances and Deployment	Web Application developed with NodeJS with RabbitMQ deployed into TeNDER and acceded with Load Balancer for Rest API and Pub/Sub for RabbitMQ. Neo4j Graph database
Programming languages	Node JS, JavaScript, CypherQL
Libraries	>= Node JS 4.4.4, Rabbit MQ 3.6.2, Neo4j Community 3.0.1
Issues & Notes	

Table 16. Service Cluster 7

5. Next steps for TeNDER Architecture

In the next few months, first functional developments will be integrated to reach the first real-scenario implementation. This process will include the attachment of the different modules into a local server. However, several issues can arise and TeNDER technical partners will find the solutions to mitigate the impact over the architecture. This deliverable will have a second report by month 15 where the final architecture will be detailed. In addition, some of the potential problems described in this section will be analysed and its solutions will be provided.

Issue Nº	Issue Description	Solution
1	Hardware capabilities: some of the proposed modules have heavy requirements in terms of Hardware (i.e. highly RAM requirements or storage)	The partners will study the information that will be locally stored and will send only the necessary subset of information to remote servers.
2	Hardware interoperability: some of the modules have extensive requirements in terms of hardware and its operability (i.e. the maximum of USB ports supported).	Hybrid solutions on hardware deployment will solve this problem.
3	Security problems	OAuth is considered by the project partners to provide authorization and authentication to TeNDER users However, additional security levels will be applied in case of need to protect sensible data like data encryption, VPN connections etc.
4	Software compatibility: some of the proposed modules will employ different software technologies, OS, etc	The technical partners will guarantee the compatibility by employing tools such as virtualization or virtual environments to avoid these problems. There are many viable solutions that are under consideration, the most suitable is to run all services as containers using frameworks like Docker, Linux containers or Kubernetes.
5	visual modelling and design tool	The consortium will study the different alternatives such as E.g. Enterprise Architect, Sparx, Visio
6	tools to support building, deploying, and automating	The consortium will analyse the viable options to decide (E.g. Jenkins, GitLab CI/CD etc).

| 7 | Data model | TeNDER partners will ensure the data model as well as databases employed and the interfaces employed for communication exchange |
| 8 | Communication channels | The consortium will study different possibilities such as HTTPS/SSL tunnel or VPN (e.g. IPSEC) |

Table 17 Potential problems

ANNEX 1. Covid-19 situation on TeNDER

A. Effects of the Covid-19 pandemic on each pilot

SERMAS	
Covid-19 Situation	During the pandemic caused by Covid-19, the primary health care centres in the community of Madrid continued to provide health care to the population, by face-to-face and by telephone. The population decreased their consultations, leaving non-urgent check-ups for later. Home visits have required a safety protocol to ensure the protection of the inhabitants of the home.
Contingency measures	During this period, the demand for care has been so high that, if another outbreak should occur, we may need to incorporate more researchers into the project, including more time to reach the agreed sample. In the event of a recurrence, protocols for protective measures would need to be established to establish contact with patients and to visit their homes and install the devices.

APM	
Covid-19 Situation	Due to the COVID pandemic, APM's activity was totally interrupted. The two rehabilitation centres and the day-care centre were closed. Home rehabilitation was also suspended from March 11st to June 1st. On June 15th, the rehabilitation centres were reopened, although with a smaller influx of patient and it will be closed three weeks on August.
Contingency measures	It is expected to recover the activity in October although it is very possible that the day care centre cannot open again in 2020. One rehabilitation centre and therapies at home had started again. At the moment, the activities with the therapists are complying with strict security protocols and limited for the absolutely necessary persons.

UNITOV	
Covid-19 Situation	During the COVID-19 pandemic the centre worked in emergency mode and, therefore, the Neurology department worked in reduced mode on management of AD and PD patients. In fact, due to the restriction of patients/professionals allowed to access to hospital and day care centre, the amount of new admissions was reduced and the normal management of patients was delayed.

Contingency measures	The expectation is to restart with the normal activities in September. On the other hand, the data will be collect minimizing the amount of personal contacts.

SKBA	
Covid-19 Situation	The Alzheimer Therapy Centre (ATC) was closed during the COVID-19 pandemic and restarted in reduced mode at the end of June. Patients with AD have difficulties to be compliant to the COVID-19 associated restrictions and measures, therefore, the ATC must be careful and monitor the development and behaviour of the inpatients and their caregivers very closely. The neurological rehabilitation hospital was treating over 80 patients with COVID-19 during the pandemic. Therefore, the number of patients for neurological rehabilitation must be reduced and new admissions avoided. Patient contact during the pandemic was allowed only for the persons absolutely necessary for the patients' treatment and care. All scientific projects requiring patient contact were set to a halt and alternative data sources were favoured.
Contingency measures	The planned workshops with patients and stakeholders were cancelled due to the risk of infection in the group of elder persons and persons with existing medical conditions. The data will be gathered in scenarios minimizing the number of personal contacts (e. g., mails, 1-on-1 interviews). This approach will lead to a higher time effort. On the other hand, it is expected that 1-on-1 interviews will generate a better data quality with less missing data.

SPO	
Covid-19 Situation	SPO activities were interrupted during the COVID-19 pandemic, all planned activities with patients and caregivers were cancelled and SPO workers were working remotely. Due to restrictions of visiting vulnerable persons, SPO has continued to support people that are living with dementia through telephone and web-based activities. The planned workshops with patients, caregivers and professionals were cancelled due to the considerable risk of infection and because of work overloaded professionals. In homes for elderly there is still considerable risk of spreading the infections and situation is changing form day to day, that is why SPO postponed planned activities and meetings in homes for elderly. Day care centres have been also closed. At the moment (July), the activities with the elderly are complying with strict health protection protocols and SPO continues with some of the activities in open spaces.
Contingency measures	We expect that situation in early September will allow us to restart with the normal activities although it is very possible that the day care centres would not be opened for external visitor again on that date. Until September, the data will be collected minimizing the amount of personal contacts.

B. Common critical points and contingency measures adopted by TeNDER

During the TeNDER project, the Covid-19 situation requires to guarantee the safety of the TeNDER project participants and the persons works on it, so, a series of measures will be taken based on the recommendations of the European Commission[10].

Should the pandemic situation require it, a security protocol will be developed to ensure safety in the interaction of researchers and participants and in the visits to the scenarios[11].

These measures will be about:

1. **Face-to-face interaction:**

In the event that all face-to-face interactions are restricted, they will be conducted by post, telephone, or video-call, according to the characteristics and needs of each participant. Conversion of physical visits into telephone or video visits. Only the strictly necessary visits will be made to the sites.

In all face-to-face situations the official protocol of each institution will be followed, in accordance with the regulations of your country and the European Union to guarantee the safety of participants and researchers.

2. **Scenarios:**

In case of day care centres and rehabilitations rooms remain closed or with restricted access there is a risk that this part of piloting will not start as planned. This shall be treated as HIGH RISK for project implementation, as many partners proposed the inclusion of the participants in day care centres or nursing home scenarios, and rehabilitation rooms.

Further, as in those scenarios, partners did not foresee several sets of devices for testing, but testing was planned with the same devices in several groups, this approach needs to be changed in relation to the considerable risk of coronavirus contamination and spreading. Therefore, partners will follow the guidance of local institution in each Member State. Following the guidance for working conditions with vulnerable groups and in closed spaces, because of the ventilation and decontamination procedures, there could be less workshops and testing groups within one day or/and within one week. Possible delays in the task competition due to lack of resources and limited access to participants should be considered.

Moreover, the mitigation for the risk in case one of the persons included in piloting gets the infection, shall be foreseen. In that case, partners shall follow the health protection guidance of national institution in each Member State and specific follow-up of these persons will be carried out during the

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[10] European Commission- Guidance on the management of clinical trials during the covid-19 (coronavirus) pandemic.

[11] European Commission- Points to consider on implications of Coronavirus disease (COVID-19) on methodological aspects of ongoing clinical trials

study. If necessary, exclusion for a set amount of days or COVID-19 testing, either for all the participants in the group, either for the researchers that will perform the piloting, shall be planned. According to national guidance that will apply, this will affect the piloting plan.

Therefore, if optional, partners shall also plan the activities and testing in open air, if possible (with some of the devices).

3. **Safe circuits:**

To ensure the safety of TeNDER's participants we will follow a special circuit during the pilots.

This safe circuit contains the following measures:

- Before each participant's use, the devices and all shared **material will be disinfected**. These measures can increase the time needed for the recruitment of participants.

- To avoid risk between contacts, during visits to the sites (homes, nurseries, hospitals, and rehabilitation rooms) both participants and workers involved in the project must use **personal protective equipment and wash their hands**, before and after the visit, as indicated by the protocol of each country. This may require more time on each visit.