5G4P Health

D2.2 Use Case Specification, Requirements Elicitation, KPIs, and Validation Plan

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PROJECT NUMBER: C2023/1-19
PROJECT NAME: Enhanced 5G-Powered Platform for Predictive Preventive Personalized and Participatory Healthcare
PROJECT ACRONYM: 5G4PHealth

Deliverable ID	**2.2**
WP number	**WP2**
Lead Partner	**ART**
Due date	**31.08.2024**
Date of submission	**31.08.2024**
Type of deliverable	**R**
Dissemination level	**PU**

Document History

Version	Person	Partner	Date
0.1	Nuran Aslantas	Artech International	31.08.2024
0.2	Chris Miles	Metrarc	23.05.2025
0.3			
0.4			
0.5			
0.6			

Executive Summary

The rapid evolution of 5G technology, combined with AI and IoT innovations, is transforming the healthcare sector by enabling more efficient, personalized, and patient-centered care. However, challenges related to data interoperability, privacy, and patient engagement persist, necessitating new approaches to harness the potential of these technologies while ensuring security and scalability. To address these challenges, the 5G4PHealth project focuses on developing an advanced 5G-powered platform that supports Predictive, Preventive, Personalized, and Participatory (P4) healthcare across diverse medical specialties.

5G4PHealth leverages a multidisciplinary consortium of AI experts and research institutions to create a holistic, AI-driven digital healthcare ecosystem. The project will develop innovative solutions such as an electronic Personal Health Record (ePHR), AI-powered diagnosis tools for posture evaluation, glaucoma, and depression management, and a white-label BiBo (Be-In-Be-Out) application for seamless patient experiences in clinical environments. These technologies will be validated and tested through pilots in four countries (UK, Spain, Turkey, and Poland), each representing different healthcare systems and patient demographics, ensuring comprehensive applicability and relevance.

The D2.2 Deliverable outlines the specification of use cases, capturing requirements from stakeholders and defining the validation methodology. It corresponds to the M1-M8 activities within Task 2.2, which focus on collecting requirements and defining key performance indicators (KPIs) that align with the project's goals. The document details the systematic approach to requirements elicitation, the design of use case scenarios, and the validation framework, ensuring that all project outcomes meet the high standards of quality and usability required in real-world healthcare applications.

Throughout the project lifecycle, continuous monitoring and iterative improvements will ensure alignment with subsequent tasks: Task 2.3, spanning M3-M10, encompasses all activities related to refining the 5G4PHealth platform, based on feedback and integration needs, while Task 2.4, running from M3-M12, includes final integration, validation, evaluation, and demonstration of the use cases. This phased approach ensures a robust validation process that addresses clinical, technical, and regulatory requirements.

The final version of this deliverable will provide a comprehensive overview of the use case validation, integration, and demonstration, highlighting the impact and effectiveness of 5G4PHealth's solutions in enhancing healthcare delivery and patient outcomes.
Note that this deliverable is not a fixed document. It will evolve during the lifespan of the project and will be further elaborated and updated.

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Table of Contents

Figure Index

1 Introduction

The vision of the 5G4PHealth project is to revolutionize the healthcare sector by enabling Predictive, Preventive, Personalized, and Participatory (P4) healthcare services. This vision will be achieved by leveraging advanced 5G-powered communication, AI-driven analytics, and IoMT (Internet of Medical Things) integration to support the effective management of health data and improve patient outcomes. 5G4PHealth aims to bridge the gap between healthcare providers, patients, and technology by providing solutions that enhance usability, privacy, data control, and seamless interoperability across various healthcare systems.

This document presents Deliverable D2.2 "Use Case Specification, Requirements Elicitation, KPIs, and Validation Plan" within the scope of WP2, outlining the planning activities for the realization and validation of three distinct use cases:

- **UC1**: AI-Powered Posture Evaluation and Gait Analysis
- **UC2**: AI-based Depression Relapse Prediction Service
- **UC3:** Intensive Care Units (ICUs) Telemedicine System
- **UC4:** Glaucoma Detection

The purpose of Deliverable D2.2 is to provide an overview of the progress achieved in WP2, focusing on the use case specifications, elicitation of technical and non-technical requirements, and defining key performance indicators (KPIs) to measure project success.
This document details the validation strategy for each use case, based on the validation criteria, requirements analysis from the implementation architecture, and test scenarios. It provides comprehensive information on the validation objectives, test cases, and workload descriptions for each use case, marking a critical step towards the implementation and operationalization of the 5G4PHealth platform.

The D2.2 document outlines the primary technical outcomes of the deliverable and is structured into seven chapters. It begins with a brief introduction in Chapter 1, followed by an overview of the work package (WP2) activities in Chapter 2.

- **Chapter 3** delivers an overview of each use case and provides details.
- **Chapter 4** outlines the validation objectives, addressing the requirements for each use case, including validation aspects and KPIs.
- **Chapter 5** discusses future work and improvements.
- **Chapter 6** concludes with a summary of the subsequent steps within the 5G4PHealth project.

This deliverable provides a comprehensive overview of the planned use cases, ensuring that each one is thoroughly defined, validated, and aligned with the project's overarching objectives. It lays the groundwork for the successful integration and validation of the 5G4PHealth platform and its components, paving the way for innovative healthcare solutions that leverage the power of 5G technology.

2 W2 Overview

The WP2 – Use case & Requirements, is one of the seven core work packages that define the 5G4PHealth project work plan.

Work Package 2 establishes the foundational steps necessary for the successful development and implementation of the 5G4PHealth platform. This work package is crucial as it lays the groundwork by providing a comprehensive state-of-the-art knowledge base, defining use case specifications and requirements, and establishing a validation plan that will guide the project's development and testing phases. Additionally, WP2 specifies the Personal Health Record (PHR) architecture, data sources, format, standards, and security measures, ensuring compliance and interoperability across different healthcare specialties. It also defines the overall system architecture, considering user access, privacy, and consent for secure information transfer and exchange within the 5G4PHealth platform.
The primary purpose of WP2 is to provide a comprehensive framework for the project's technological and architectural foundation, including state-of-the-art analysis, use case specifications, requirements, and validation plans. This framework ensures the 5G4PHealth platform's alignment with project goals and compliance with relevant standards, supporting the successful development of innovative healthcare solutions.
WP2 is organized into four main tasks running from M1 to M12, as detailed below:
Task 2.1: State-of-the-Art (M1-M6): This task involves developing a comprehensive knowledge base that encompasses the latest advancements in 5G technology, biomedical sensing, context-aware user-centered experiences, IoMT platforms, Be-in Be-out concepts, innovative AI-driven services for digital care, Personal Health Record (PHR) solutions.
Task 2.2: Use Case Specifications, KPIs and System Requirements (M1-M8): This task defines the detailed specifications for each use case scenario, including the architecture, data flows, and user interactions. It translates the requirements into tangible use case descriptions and documentation for implementation.
Task T2.3: Electronic Personal Health Record (ePHR) Specifications (M3-M10): This task will focus on defining the specifications for the Personal Health Record (PHR) to ensure it meets user needs and aligns with the project's objectives. It includes defining the types of healthcare data to be aggregated, identifying data sources, specifying data formats and standardization procedures, implementing data security measures such as encryption to protect patient information, and creating a maintenance plan to keep the PHR updated and relevant over time.
Task T2.4: System Architecture and Design Specifications (M3-M12): This task will be responsible for defining the 5G4PHealth solution architecture, addressing both the in situ clinical environments (including the Physical Layer, IoMT platform, Data Layer, and BiBo App) and the main 5G4PHealth Platform Environment (comprising the 5G4PHealth Integration and Data Exchange Layer, Shared Data Layer, PHR App, and Service Layer). It will specify the hardware and software platform for acquiring multimodal patient data, controlling actuators based on user preferences, and ensuring hardware-software interoperability.

Within WP2, three deliverables are scheduled to be submitted between M10 and M12:
D2.1: SotA (M10)
D2.2: Use Case Specification, Requirements Elicitation, KPIs, and Validation Plan (M10)
D2.3: 5G4PHealth Specifications and Design (M12)
In summary, WP2 aims to provide a comprehensive foundation for the 5G4PHealth project by establishing a state-of-the-art knowledge base, defining use case scenarios and requirements, specifying the Personal Health Record (PHR) architecture, and developing the overall system and platform design. This ensures that all technological, architectural, and security aspects are

well-defined to support the successful implementation, validation, and interoperability of the 5G4PHealth platform.

3 Use Case Overview

The 5G4PHealth project focuses on enhancing the quality, accessibility, and efficiency of healthcare through advanced 5G-powered solutions. The project aims to validate its innovative technologies across four distinct healthcare use cases, each addressing different clinical challenges and end-user needs. These use cases include AI-driven diagnostic tools, patient monitoring systems, and telemedicine applications, reflecting the project's commitment to delivering value-based, patient-centered healthcare services.
The project's solutions will be demonstrated through four use cases, each showcasing the capabilities of the 5G4PHealth platform in addressing critical healthcare needs and ensuring seamless integration of advanced AI and IoMT (Internet of Medical Things) technologies. Each use case will be deployed and validated within specific healthcare environments across different pilot sites, representing a broad spectrum of medical specialties and patient demographics.

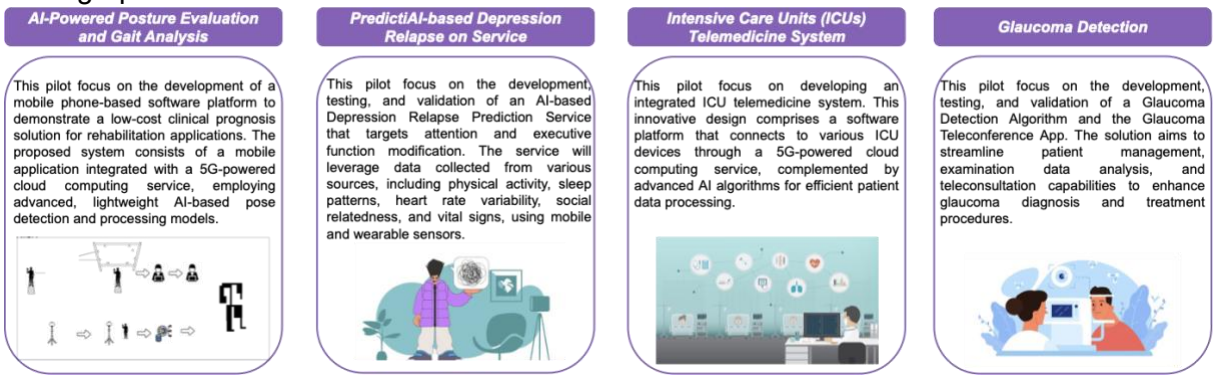

Figure 1: Use Cases Overview

Each use case is designed to demonstrate the potential of 5G4PHealth solutions in real-world healthcare settings, offering a comprehensive evaluation of the platform's robustness, flexibility, and effectiveness in diverse medical contexts. By validating these use cases in different healthcare systems and pilot sites, 5G4PHealth aims to provide a thorough assessment of its platform, paving the way for the adoption of innovative 5G-powered healthcare solutions on a broader scale.
The following sections provide detailed specifications, requirements, and validation plans for use case 1,2,3, highlighting their unique contributions to the project and the overall healthcare landscape. The necessary information for Use Case 4 will be included in the second revision of the report, as the national funding decision for the pilot providers MVC and PSNC is expected to be finalized in the 12th month of the project.

3.1 UC1: AI-Powered Posture Evaluation and Gait Analysis

3.1.1 Scope and Objective of Use Case

Scope: This use case will integrate within the 5G-capable cloud-connected platform developed by Metrarc. More specifically, we will develop a real-time pose estimation tooling that combines artificial intelligence, 5G communication and patient feedback reporting system, permitting

portability, ease of use and inexpensive equipment[1]. Metrarc will work with sport scientist colleagues to develop a timed up-and-go test (TUG) for a mobile test application, to examine the patient's balance, gait, and overall functional capacity.

Objectives:

- Develop a real-time pose estimation algorithm that is capable of extracting skeleton data from a video.
- Validate the developed algorithm using as a reference a marker based system.
- Develop Semantic Communication (SC) for video based rehabilitation system.
- Determine the user specifications for the TUG to be applied as part of this use case, including the different stages that take part of the timed up-and-go task.
- Integrate the developed algorithm into a suitable cloud platform.
- Carry out a user study to evaluate the usability of the TUG through a mobile platform as a therapeutic tool.

3.1.2 Complete Use Case Description

3.1.2.1 AI Based Monocular Gait Measurements

The overview of AI-based monocular markerless gait measurements workflow is illustrated in Fig.1, the proposed AI-based methods can be divided into the following five tasks: 1) Collect videos data, where video data of health participants will be required, and video of walking activities will be collected in lab environment. 2) Use the 2D object detection neural network framework to locate the human object from the videos; 3) Utilize the 2D pose estimation network to predict 2D coordinates of human joints; 4) Utilize the 3D pose estimation network or similar technology to transform 2D coordinates into 3D coordinates of the joints; 5) Compute the joint angles with the predicted 3D joint coordinates. In this use case, the gait signals will be confined into several biomechanic metrics, e.g. joint angles between upper arms and lower arms, thighs and legs, etc.. The reason behind this choice is that 1) Joint angles are one of the significant indicators that can discriminate abnormal gait, helping the diagnosis of gait-related conditions; 2) Joint angle will stay constant after rotation and translation transformation, which is convenient to computation in different viewpoints; 3) Joint angles are standard measurement for measuring and standardizing across different individuals and studies.

[1] Davies, E. H., Matthews, C., Merlet, A., & Zimmermann, M. (2022). Time to See the Difference: Video Capture for Patient-Centered Clinical Trials. The patient, 15(4), 389–397. https://doi.org/10.1007/s40271-021-00569-1

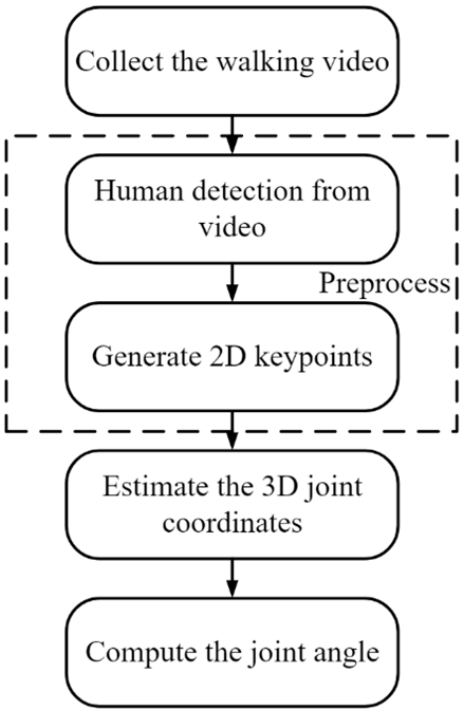

Figure 2 Workflow of AI-based Monocular Gait Measurement

3.1.2.2 Video based Timed Up-And-Go Test

The Timed Up and Go (TUG) test is a widely-used assessment tool in physical therapy that measures a patient's mobility, balance, and risk of falling. With assistance from sport scientists, Metrarc will build an app for a mobile device that can record the TUG test with capability to upload videos to the cloud platform. Once the video is uploaded practitioners can evaluate the video to extract the Timed up and go timing, or through automated analysis this can be automatically extracted.

The TUG test involves a patient standing up from a chair, walking a distance of 3 meters, turning around, walking back to the chair, and sitting down. The test is timed, and the speed and efficiency of the task help indicate the individual´s functional mobility and balance. On a video based scenario a tripod is placed 5 meters on front of the chair so that when the person walks 3 meters, they will be 2 meters away from the camera and still in frame.

3.1.2.3 Integration of vTUG into the cloud platform

The cloud platform will support the collection, analysis, and visualization of health data to help healthcare providers, pharmaceutical companies and researchers assess patient outcomes. It consists of a web interface that can be accessed by clinicians and a mobile app for participants that can be downloaded into android or iOS devices.
For the integration of the TUG Assessment a secure cloud platform specific for the 5G4PHealth project will be created which will consist of a User sign-up, and various questionnaires, including the video recording for the TUG. Once a questionnaire is filled it will be uploaded to the back-end and processed for automated analysis.

The integration of the posture detection algorithms will be done in two parts according to the computational power requirements of the algorithm. As a starting point this algorithms will be executed on a server as non-real time allowing the process to take the time required for extraction. Eventually the algorithm will be integrated into the mobile device for the evaluation of real-time capabilities.

3.1.2.4 TUG Analysis and Verification

Once pose estimation has been processed, data analysis of the generated landmarks will be executed in the captured videos, and TUG parameters will be extracted. Additionally to the total time of TUG, individual stages will be captured allowing the identification of when the person is standing, walking, turning and sitting. Other parameters such as balance, and gate will be evaluated.

3.1.2.5 Semantic Communication (SC) for Rehabilitation System

The traditional rehabilitation system was normally marker-based where the patients may need to use wearable sensors and perform some movement in front of the system. In this case, the patient may be required to attend the appointment in the hospital. However, for the markerless system, as no special requirement is required, the patient can use the camera from their mobile device at home to discuss with doctors, where the doctors can see the real-time videos or movement of the patients. To save the wireless transmission bandwidth, SC may be applied. In this caes, after the patient performs physical therapy exercises will be captured by the mobile camera, the semantic information, i.e., the skeletons will be extracted, encoded and then transmitted based on different situations of the wireless network conditions. As represented in the figure, at the doctor's side, the full movement will be recovered based on the received skeleton with the help of AI-generated content (AIGC) techniques in a (near) real-time. Also, Mhformer maybe used in extracting the skeletons [2].

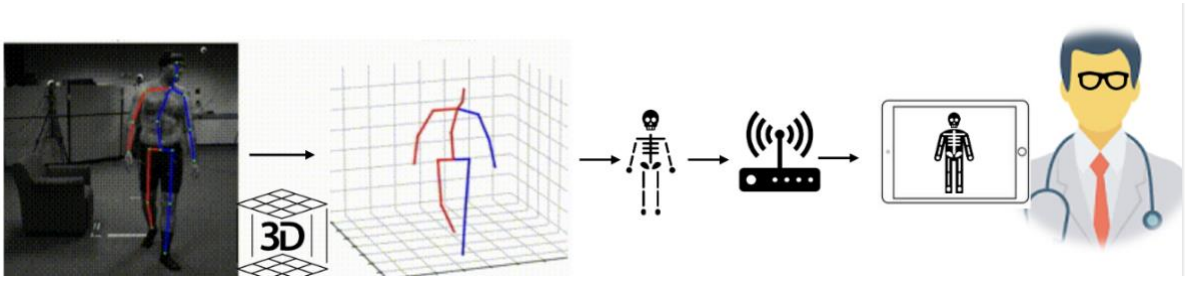

Figure 3 Semantic Communication (SC) for Rehabilitation System

3.1.3 Validation Environment

3.1.3.1 AI-based Monocular Gait Measurement

Data collection: we will collect video data for both marker (ground truth) and markerless motion capture systems from at least 20-25 health participants (e.g. Age between 18 to 60

[2] Wenhao Li, Hong Liu, Hao Tang, Pichao Wang, Luc Van Gool; Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), 2022, pp. 13147-13156

years old, 2) self-reported absence of any medical conditions that would preclude safe completion of maximal effort walking, running, and jumping activities; 3) absence of a lower-limb pain/injury within the last 3 months) performing walking, running, jogging, and jumps of various intensities whilst their motion is captured using a single camera. walking, running, jogging, and jumps of various intensities whilst their motion is captured using a single camera. In addition, we will also process our previous collected marker-based ground truth data, using computer graphics rendering techniques to reconstruct 2D videos, which will be mainly used for training AI models to complement the real data collection.

Markerless post detection: we will design a pre-processing algorithm to improve key point detection and estimate 3D markerless post detection system using transformer-based approaches, which combines spatial and time-frequency feature extractions.

Lab validation: we will conduct a lab test with ground truth data for the markerless system, and give a comprehensive evaluation of the performance of the markerless system against our 14 camera Vicon system in terms of various biomechanic metrics mentioned section 3.1.2.1.

3.1.3.2 TUG Analysis Validation

For the TUG analysis validation a group of videos will be selected to be manually annotated, This will be done through an interface that allows the visualization of each video, and recording of specific time intervals of when the TUG starts, and when each individual stage happens. This will be then compared with the data extracted by the automated analysis.

3.2 UC2: AI-based Depression Relapse Prediction Service

3.2.1 Scope and Objective of Use Case

Scope: Today depression is one of the most relevant public health problems worldwide and adolescents are one of the populations most susceptible to the impacts of depressive disorders. To address this need, the project AI4TeenDep will seek to develop a non-invasive tool for the interpretation of mood changes, voice modifications and other markers facilitating the timely care of potential patients.
In this sense, the proposed development is not presented as a diagnostic tool (solutions still lacking precision) but as an instrument that will provide professionals with objective information for decision making and personalized recommendations, improving patient self-management and reducing the burden of the disease.

Objectives:

General Objective:
To design and develop a screening platform/app that collects and interprets data related to depression in adolescents based on the analysis of executive functions and the recognition of vocal parameters.

Specific Objectives:

OT 1: To develop the Mobile Application
- Develop the Mobile Application
- Create AI API

OT 2: To implement the Central Application
- Implement the Central Application

OT 3: To optimize Key Functionalities
- Develop AI Models Based on Executive Functions
- Develop AI Models Based on Audio
- Develop AI Models Based on Executive Functions + Audio
- Validate AI Models

OT 4: To meet Non-Functional Requirements
- Meet Non-Functional Requirements

OT 5: To ensure Security and Communication
- Ensure Security and Communication

3.2.2 Complete Use Case Description

Today depression is one of the most relevant public health problems worldwide and adolescents are one of the populations most susceptible to the impacts of depressive disorders. To address this need, the project will seek to develop a non-invasive tool for the interpretation of mood changes, voice changes and other markers to facilitate the timely care of potential patients. In this sense, the proposed development is not presented as a diagnostic tool (solutions still lacking precision) but as an instrument that will provide professionals with objective information for decision making and personalized recommendations, improving patient self-management and reducing the burden of the disease.

System Architecture

The platform resulting from the AI4TeenDep project will be structured by two applications, one for mobile devices (Mobile App) for users and a central application (Central App) for health professionals and caregivers. IDavinci will be in charge of the design and development of these applications, which will be integrated with the AIEngine developed by Horus.

On the mobile phone app, users will authenticate themselves to access the platform and respond to surveys related to their psychological and cognitive state. They will also be able to record their voices that retrieve related information. All of this information is securely sent to the central app. In the core app, the information will be processed to create depression-related diagnoses and alerts among users. In addition, we may import data from other sources to ensure that the information is consistent. We will also train the system using artificial intelligence so that it can learn and improve over time. In addition, we will perform automated tests to make sure everything is working properly and we will record important events to follow up properly.

The tool is composed of the following elements:

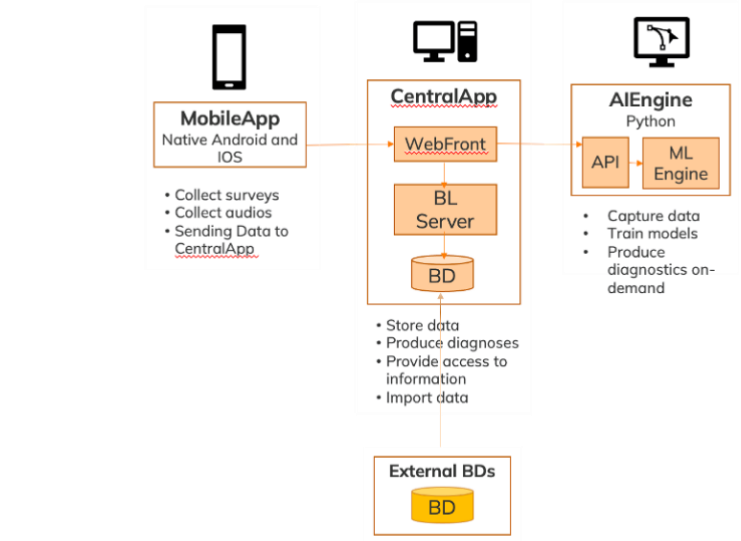

Figure 4 System Architecture

The **Mobile App** is designed to handle various user-facing functionalities. It includes an Authentication and Authorization Module to manage user access and permissions, ensuring secure login and role-based access to different parts of the app. The User Management Module enables the creation, modification, and deletion of user accounts, supporting both profile and role management. The Survey Module allows users to complete and submit surveys seamlessly from the MobileApp to the CentralApp. Additionally, the Audio Recording and Sending Module offers features for recording audio files and securely transmitting them to the CentralApp for storage. The User Interface (UI) Module is responsible for presenting information in a user-friendly and consistent manner, making navigation easy. Finally, the API Communication Module ensures that the MobileApp communicates securely with the CentralApp, safeguarding data during transfer.

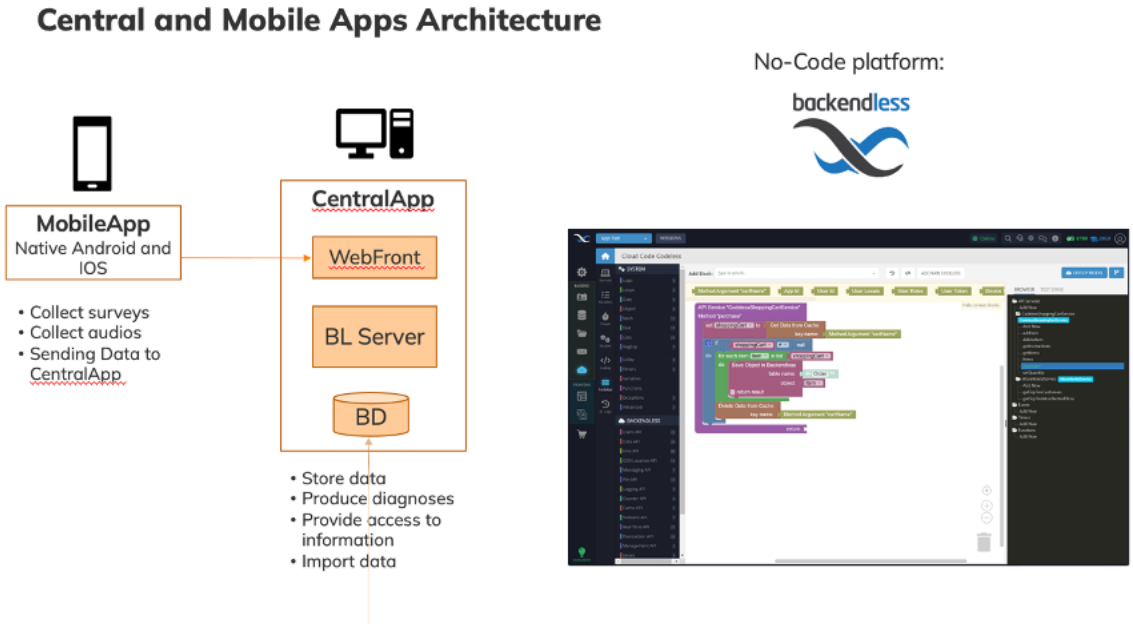

Figure 5 Central and Mobile Apps Architecture

The **Central App** focuses on backend operations and data processing. Its Authentication and Authorization Module mirrors the Mobile App's security features, managing user access to the system. The User Management Module allows for the administration of user accounts, including creation, modification, and deletion, along with role management. The Diagnostics Module is a critical feature, processing collected data to generate insights and diagnoses using either predefined rules or machine learning models. The External Data Import Module ensures seamless integration of external data into the CentralApp, maintaining coherence with existing information. Additionally, the Training Module (MLEngine) handles machine learning model training, utilizing the collected data to improve the accuracy of diagnostics and insights over time.

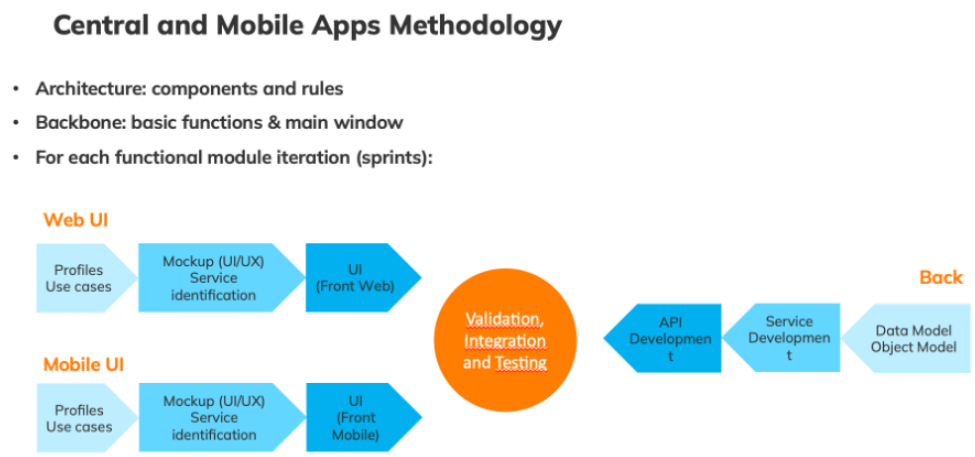

Figure 6 Central and Mobile Apps Methodology

AIEngine Architecture and Methodology

Objective: Supervised Machine Learning Models for the automatic recognition of depression states in adolescents.

Input: Structured data (F.E.) + unstructured data (audios and their transcription to text).

Models: Stacking Ensemble.

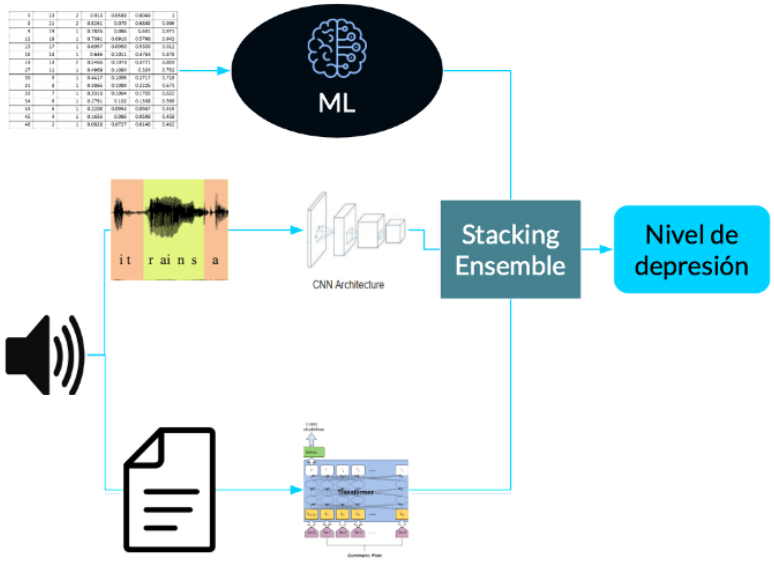

Figure 7 AIEngine Architecture

AIEngine Methodology

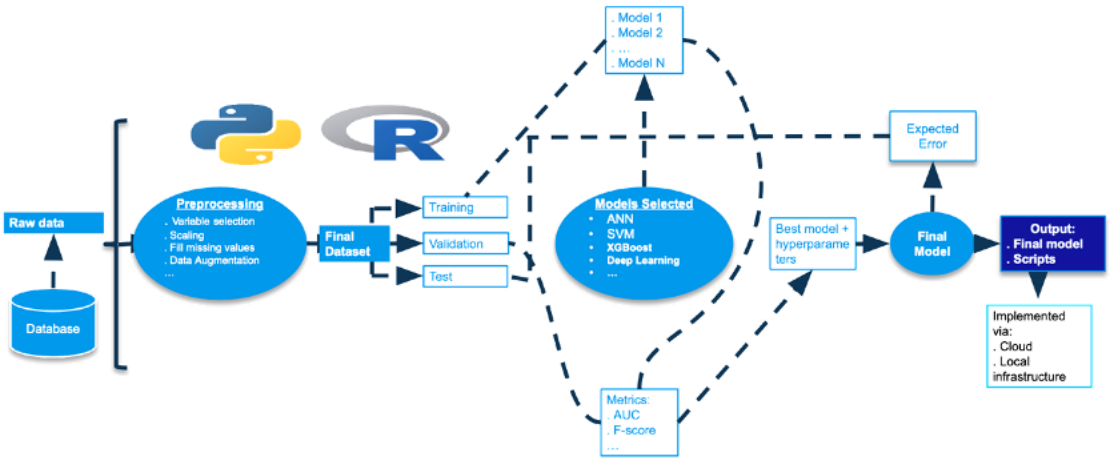

Figure 8 AIEngine Methodology

Objective: Supervised Machine Learning Models for the automatic recognition of depression states in adolescents.

Input: Structured data (F.E.) + unstructured data (audios and their transcription to text).

Models: Stacking Ensemble.ar their effectiveness and clinical utility. Various metrics will be analyzed: AUC, sensitivity, specificity, positive predictive value, negative predictive value, F1 score, PRAUC.

AlgorithmsAI

[1] Input

Two data sources will be used as input data:

- **Executive functions:** They consist of structured data with one row per individual within the study cohort in which a series of characteristics or variables are included that will be used as predictive variables by the model.
- **Audio files:** These consist of unstructured data corresponding to audio recordings that will be requested from each of the individuals in the study cohort. They will be used as input to Machine Learning models, both in their original audio format and in text format after their transcription.

As usual in Machine Learning, the data will be divided into different subsets:

- **Train:** This dataset is used to build the model, selecting the best parameters or weights for this particular set. These optimal weights will be those that minimize a certain loss function or target function.
- **Validation:** ML models have a number of possible configurations or hyperparameters. To select the best combination of hyperparameters, this validation set is used. The selected hyperparameters are the ones that minimize the model error on this validation set, based on a particular choice of evaluation metric, which in our case will be the area under the ROC curve, AUROC.

In many cases, this validation set is not explicitly used, and instead a technique called cross-validation (CV) is used as a method to find these optimal hyperparameters of the model. In cross-validation, the training dataset is divided into k subsets or folds. The model is then trained using k − 1 of these subsets and the remaining one is used as a validation set. This process is repeated k times until all subsets have played the role of validation set. The errors resulting from these k iterations are averaged and used as a final validation error.

In this project we will choose to use this cross-validation technique.

- **Test**: The model created from this process is used to make predictions of depression levels on new instances that belong to a third division of the dataset that has not yet been used, the test set. The prediction errors for this test subset are used as a measure of the expected accuracy of the model, as they are data that the model had not seen in its training and therefore are expected to get a prediction error similar to new data that arrives in a real-world situation.

[2] Output

The output of the model will be, for each individual, a score in the interval [0.100], which will correspond to the expected probability of the presence of depression states for that individual.

[3] Models

In our proposed method, the following types of Machine Learning models for executive function structured data will be analyzed:

- **Random Forest, RF:** Combination of different highly complex classification trees. Each sample is classified as the mode obtained among all the individual trees. Its end use was discarded after testing because it obtained less accuracy than the other models.

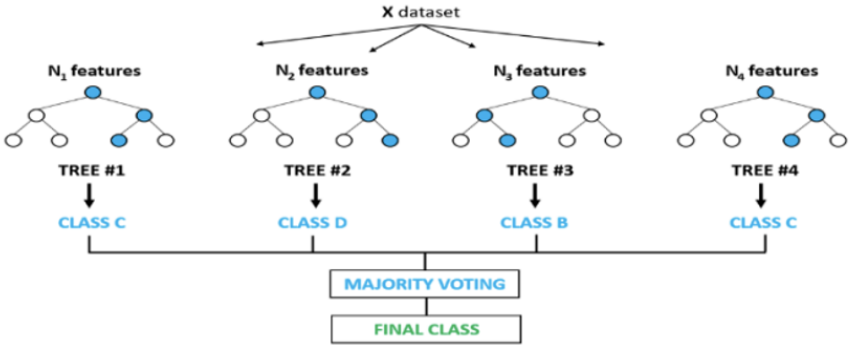

Figure 9 Random Forest Architecture

- **Support Vector Machines, SVM:** Constructs a hyperplane or set of hyperplanes in a very high dimensional space that can be used in classification problems to separate classes or regression to predict the target.

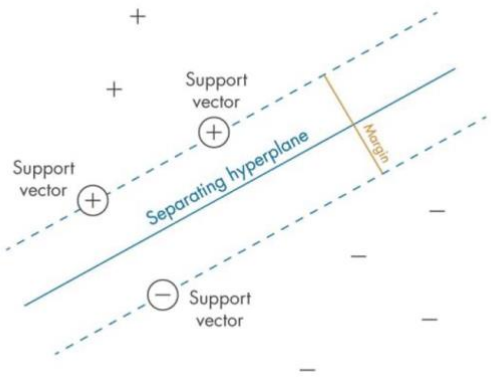

Figure 10 SVM Architecture

- **Neural Networks, NN:** It consists of a set of units, called neurons, distributed in several layers connected to each other. The information goes from the input layer to the output layer, undergoing transformations in each of the neurons, resulting in a final prediction.

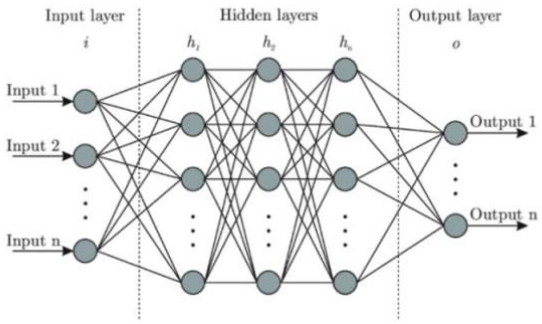

Figure 11 Neural Network Architecture

- **Gradient Boosting, GB:** Gradient Boosting models build an ensemble of uncomplex models, usually classification trees. Several variants of these Gradient Boosting models will be analyzed, specifically XGBoost, LightGBM and CatBoost.

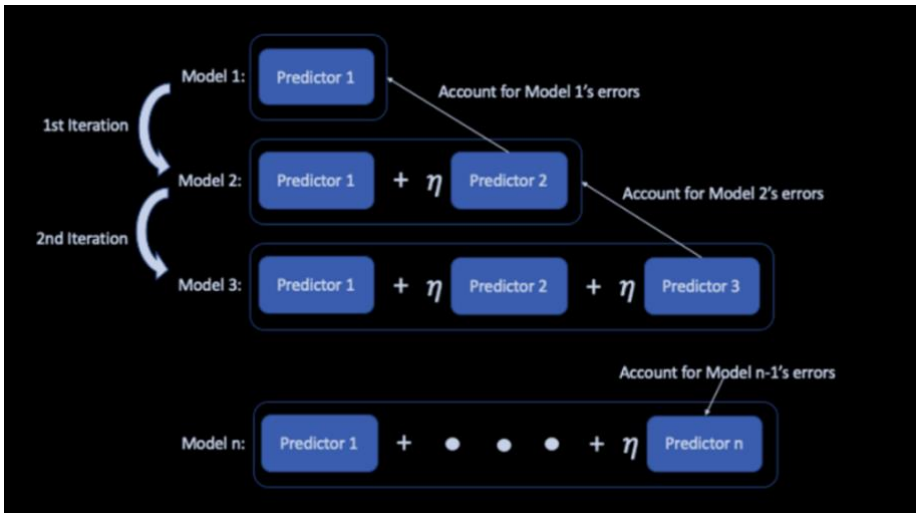

Figure 12 Gradient Boosting Architecture

For unstructured audio and text data, the following types of Machine Learning models will be evaluated:

- **Convolutional Neural Networks, CNN:** They present a set of very advantageous properties for use in audio classification tasks and in recent years they have become the state of the art for this type of problem, being their for the automatic analysis of audio widely studied in recent years.

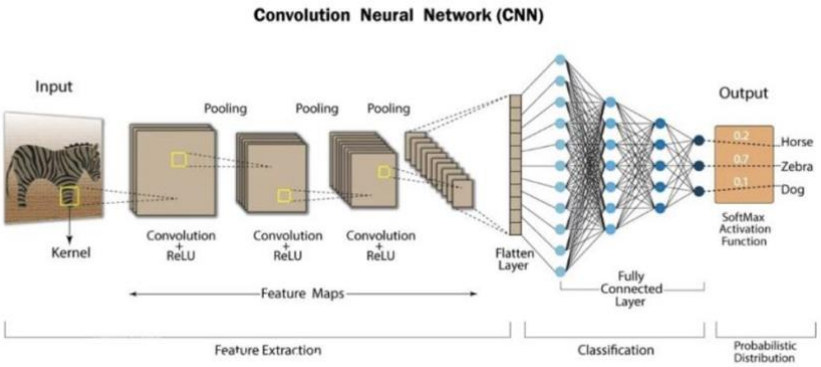

Figure 13 CNN Architecture

- **Transformers:** They were introduced in 2017 by a team from Google Brain and are increasingly the model of choice for Natural Language Processing problems, replacing Recurrent Neural Network models, the previous state of the art in this field of ML. In addition, although they were not initially designed for this purpose, it has been observed that these structures can be adapted to be used in images, videos and audio, where they have shown great potential, surpassing in some studies even the results obtained by CNNs, the reference so far. However, their ability to replace these architectures as state-of-the-art in this type of task still requires further research.

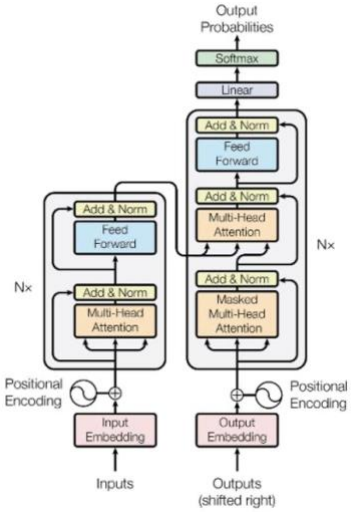

Figure 14 Transformer Architecture

Finally, to combine models based on structured data of executive functions and models based on unstructured audio and text data, the following family of Machine Learning models will be analyzed:

- **Stacking Ensembles:** The best models resulting from each of the previous types are combined, both models based on structured data of executive functions and models based on unstructured audio and text data, using a supervisory model that has as input the outputs of each of these models.

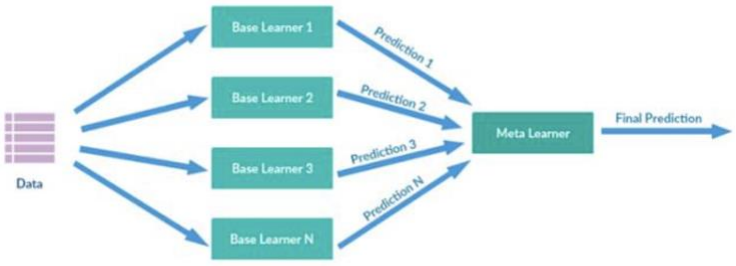

Figure 15 Stacking Ensemble Architecture

Among all these models described, the final model to be used is determined in the metamodelling module, explained later in this document, based on the evaluation metrics obtained on the validation set.

[4] Methodology

The method we propose is composed of different phases, as shown in the following diagram:

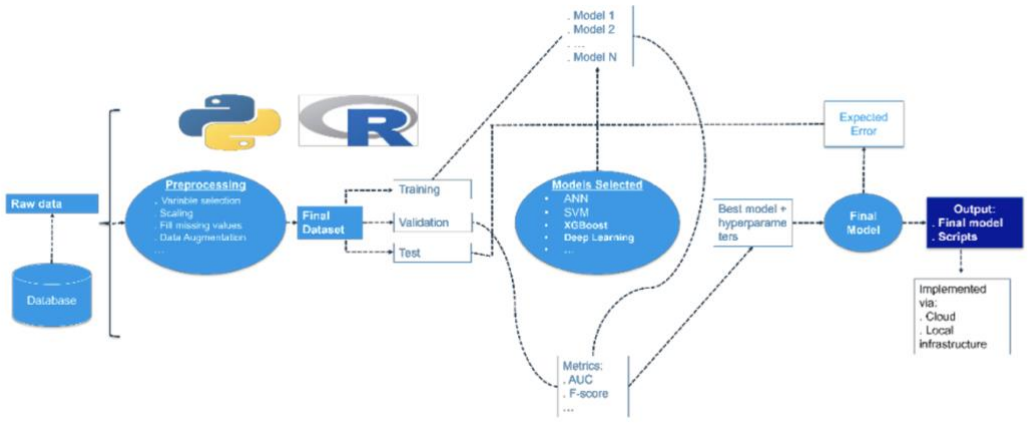

Figure 16 Methodology

Preprocessing: Analytical preprocessing of available data in order to prepare it for use as input to a machine learning model. This task involves several steps:

- Oversampling: Synthetic creation of new records of the minority class, in this case individuals with depression.
- Subsampling: Random elimination of records from the majority class, in this case individuals without depression.
- Eliminate constant variables: Discard variables with a standard deviation equal to 0.
- Eliminate unreported variables: Discard variables with a very high ratio of unimputed values.
- Fill in unreported values: Application of techniques, such as Multivariate Imputation with Chain-Equation or MICE, to infer unimputed values.
- Group categories: Reduce the number of possible categories in some predictor variables by grouping them according to their meaning or common characteristics.
- Coding: Transform categorical variables into numerical variables, using techniques such as One-hot encoding or label encoding.

- Scaling: Bringing all variables to the same scale. In our case we will use standard scaling, transforming all the variables to mean zero and standard deviation one.
- Eliminate irrelevant variables: Discard predictor variables with a very low correlation with the target, in this case the presence or absence of depression.
- Eliminate redundant variables: Discard predictor variables with a very high correlation with other predictor variables.
- Importance of the variables: Select only the variables that show a higher importance score after applying permutation importance techniques.
- Weighting: Give different weights to individuals of the minority class, presence of depression, with respect to those of the majority class, no presence of depression.
- PCA: Apply Principal Component Analysis to reduce the dimensionality of the dataset to be used.

The pipeline to be developed will allow different combinations of preprocessing steps to be tested, as well as different configurations or thresholds for each of them, so that the configuration of preprocessing steps that provides a better evaluation metric, AUROC in this case, on the validation set will finally be chosen.

Transfer Learning: In the case of models that use unstructured data as input, i.e. Transformers and Convolutional Neural Networks, we will apply a technique available for this type of Machine Learning families called *Transfer Learning*.
Specifically, we will apply this technique to take advantage of the knowledge extracted by CNN and Transformers models from previous research in more generic tasks of automatic audio and text analysis. When applying *Transfer Learning*, instead of building Machine Learning models from scratch, we start from the architecture and available weights of these more generic models, usually built with large volumes of data, and then specialize them in a more specific task, in our case the detection of depression in adolescents, through a second iteration of training with our own dataset. In this way, the knowledge extracted from larger and more generic datasets can be reused and the volume of data needed to build models with a high predictive potential is reduced.

Metamodeling: The metamodeling, hyperparameterization or backtesting phase aims to choose which type of model and hyperparameter configuration is optimal for the problem to be solved.
To this end, all the configurations, or combinations of hyperparameters, that are to be tested using the same train set for each of them are trained for each family of models described above. Next, the error obtained for each set of hyperparameters on the same validation set is calculated; The combination that obtains the minimum error will be the one considered optimal and the one that will be used as the final model in the screening platform/app.
To calculate this error or level of fit of the model, the area under the curve corresponding to the Receiver Operating Characteristic, or ROC curve, will be used as the main metric. This curve represents the sensitivity, or true positive ratio, VPR, versus the specificity or true negative ratio, FPR, for a binary classification model as the discrimination threshold from which a sample or episode is classified as positive, depression, or negative, not depression, is varied.

The definitions of the VPR and FPR values are as follows:

$$VPR = \frac{VP}{VP + FN}$$
$$FPR = \frac{VN}{VN + FP}$$

where:
True positives, PV: Individuals with depression that the model classified as depression, that is, it was right.
False negatives, FN: Individuals with depression that the model classified as non-depressed, that is, it was wrong.
True negatives, VN: Individuals with non-depression that the model classified as non-depressed, that is, it was right.
False positives, FP: Individuals with non-depression that the model classified as depression, that is, it was wrong.

In addition, the following metrics will also be analyzed:

- **Sensitivity:** Also called recall. It is the ratio of the ratio of true positives.
- **Specificity:** Ratio of true negatives.
- **Positive predictive value:** Probability of having depression if the result of the diagnostic test is positive.
- **Negative predictive value:** Probability of not having depression if the result of the diagnostic test is negative.
- **F1 Score:** a measure that combines positive predictive value and sensitivity. Measure whether our model has false positives and false negatives at the same time.

Training: In this phase, the final model to be put into production is built. In the training phase, only the model belonging to the family that was chosen in the metamodelling phase will be taken into account.
In this step, the train, validation, and test subsets will be combined into a single combined dataset, and a final model will be trained with this data based on the model family and hyperparameter combination that won in the metamodeling phase. In this way, we will have a final model that has been trained with as much data as possible.

Prediction: The prediction phase consists of the production operation of the model built in the training phase.
At this stage, different inputs, in the form of new records not available in the dataset used as input from the model trained in the previous phase, are passed to the model to generate predictions of the probability of suffering from depression.

[5] Implementation

The implementation of all stages of the method described above will be done using the R and Python programming languages. Both R and Python are open source languages, so they do not require any type of paid license and their installation and use is accessible to any user or institution.

The computation of the models required for their training and validation will be carried out on cloud computing servers hosted on Amazon AWS in the Spain region.

Visualization
Data visualization will follow key principles that ensure clarity, simplicity, and controlled interactivity, adapting to different users and promoting accessibility. These actions seek to make the visualizations effective, understandable and accessible to a variety of users, while fostering confidence in the results presented by the artificial intelligence system.

Specific actions to meet these criteria are detailed below:

1 **Clarity and Simplicity:**
- We will use simple and clear visualizations that facilitate the understanding of the information.
- We will avoid excessive use of graphics or complex visual elements that can generate confusion.

2 **Controlled Interactivity:**
- We will allow users to explore the data intuitively through interactive features.
- We will ensure that interactions are clear and free of confusion, while maintaining control over the complexity of the interactive options.

3 **Explain the Model:**
- We will include explicit information about how the artificial intelligence model works to generate the results presented.
- We will provide clear explanations about the decisions made by the model, improving users' trust and understanding.

4 **Adaptability to Different Users:**
- We will design visualizations that adapt to different levels of experience and knowledge of the users.
- We will offer options to view advanced details or limit information for less technical users, allowing for a personalized experience.

5 **Accessibility:**
- We will ensure that visualizations are accessible to users with disabilities, using contrasting colors, descriptive labels, and other inclusive design practices.
- We will ensure compatibility with assistive technologies to improve accessibility.

6 **Data Transparency:**
- We will provide transparent access to the underlying data source, allowing verification of the information submitted.
- We will be transparent about the quality and up-to-date data used in the AI solution, establishing user trust.

7 **Validation and Continuous Evaluation:**
- We will conduct ongoing testing and evaluation of visualizations with real users to identify potential improvements.
- We will accept feedback from users to improve the usability and understanding of the visualizations, ensuring a constant evolution of the system.

3.2.3 Validation Environment

The validation environment for the proposed tool is based on the target population of adolescents in educational institutions (schools and high schools) within Spain, particularly those facing mental health challenges such as depression. Given the prevalence of these

issues among adolescents, the project will focus on implementing and testing the tool in real-world educational settings.

We plan to initiate the validation process in the Community of Madrid, where the solution will be piloted and gradually scaled to other regions. In Madrid alone, there are 361 public high schools, serving 41,642 students in 2023, and 468 private and semi-private schools, with 28,810 students. These institutions typically host classrooms of 25-30 students, making them an ideal environment for testing and validating the effectiveness of the tool on a diverse and sizable sample of adolescents.

The validation process will be structured into multiple phases, including:

1. Sample Selection (PT1 T1.3):Establishing criteria for inclusion and exclusion to ensure a robust and representative sample of adolescents. This phase will focus on avoiding biases through randomized selection of schools and ensuring data diversity. Ethical considerations like informed consent and data protection will also be thoroughly addressed.

2. First Psychological and Cognitive Measurement (PT2 T2.1): Baseline data will be collected from 1,500 adolescents in secondary education. This step is critical for building the predictive model of mood and cognitive changes, and will be supported by psychological resources to ensure accurate data collection and minimize environmental disturbances during testing.

3. Second Psychological and Cognitive Measurement (PT4 T4.1):The evaluations will be repeated with the same participants to track changes over time. The same psychological support will be provided to maintain data integrity and ensure that the tool is capturing the desired emotional and cognitive markers.

4. Pilot Testing of the Tool (PT4 T4.2):The tool will undergo pilot testing in a small sample of participants to identify any potential issues or areas for improvement before wider implementation. This step is essential to ensure the tool's reliability and effectiveness in providing actionable insights for professionals and assisting in patient self-management.

This staged validation environment will ensure that the tool is both reliable and scalable, with the aim of providing professionals with objective data for decision-making and offering adolescents personalized support in managing their mental health.

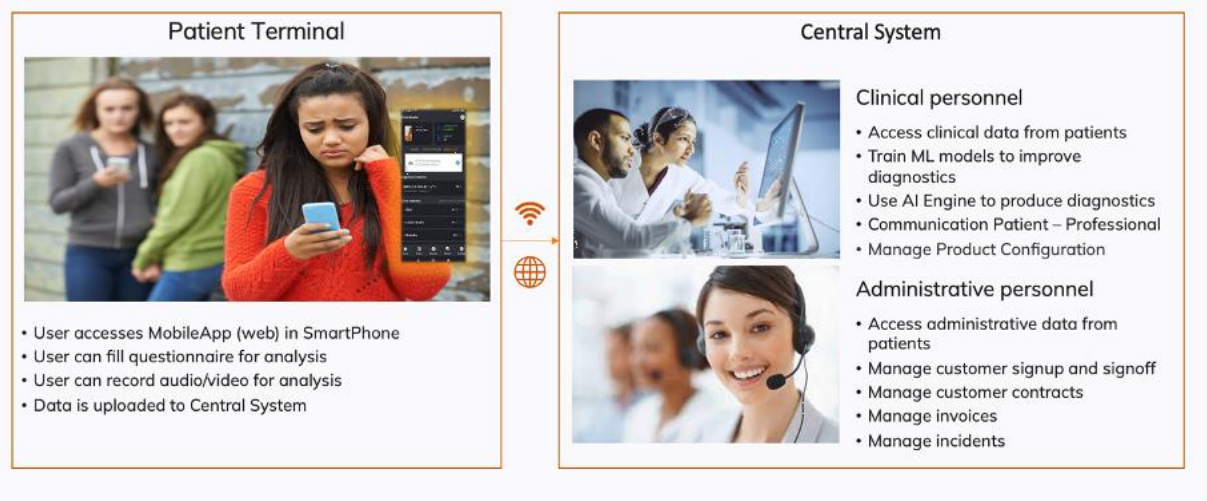

Figure 17 Validation Process

3.3 UC3: Intensive Care Units (ICUs) Telemedicine System

3.3.1 Scope and Objective of Use Case

Scope: This section outlines the overall framework of the project and the role of the Turkish Consortium within it. The Turkish Consortium aims to integrate innovative solutions using 5G technology in healthcare services. Providing expertise in Electronic Personal Health Records (ePHR) and system architecture is a crucial step towards enhancing user experience.

Objectives:

ePHR Specifications

Focus will be on defining the requirements for the PHR, including:

User Data: Medical history, medications, lab results, and imaging outcomes.

- Data Sources: Hospitals, clinics, and manual data entry.
- Data Format: Structured and unstructured data.
- Data Security: Encryption and access control measures.

System Architecture

The system architecture will define the technical structure of the 5G4PHealth platform, encompassing the following components:

- IoMT platform
- Data acquisition and control systems
- User access and security measures

IoT Device Requirements

The requirements for IoT devices to be used in the project will be outlined. These requirements may include:

- **Data Collection:** Types of health data to be collected and the frequency of collection.
- **Communication Protocols:** Connectivity options such as Wi-Fi, Bluetooth, or 5G.
- **Security:** Data encryption and authentication methods.
- **Energy Efficiency:** Battery life and energy consumption.
- **Compliance:** Adherence to health data standards and privacy regulations.

Data Security and Privacy

Data security and privacy are fundamental components of the project. The following measures will be implemented to ensure the protection of user data:

- **Encryption Methods:** Secure storage of user data.
- **Access Controls:** Role-based access control systems.
- **User Information:** Informing users about how their data will be use

3.3.2 Complete Use Case Description

The use case for the integration of 5G technology in healthcare through Electronic Personal Health Records (ePHR) involves several key actors, including patients, healthcare providers, and IoT device manufacturers. The process begins with IoT devices collecting vital health data, such as medical history, medications, lab results, and imaging outcomes. This data is securely transmitted using communication protocols like Wi-Fi, Bluetooth, or 5G. The encryption of data during transmission is ensured to protect user privacy, and secure storage is maintained in accordance with established encryption methods. Patients can access their ePHR via a user-friendly interface, and role-based access controls are implemented to effectively manage user permissions. Throughout the process, patients are informed about how their data will be utilized, enhancing transparency. Healthcare providers benefit from real-time data monitoring, improving their decision-making and overall patient care.

3.3.3 Validation Environment

To ensure the successful implementation of the 5G4PHealth platform, a comprehensive validation environment will be established. This includes creating the necessary technical infrastructure, such as the IoMT platform and data acquisition systems, and integrating IoT devices with the 5G network. Testing protocols will be employed to validate data collection and transmission processes, as well as to assess the effectiveness of security measures like encryption and access controls. User acceptance testing (UAT) will be conducted with a diverse group of patients and healthcare providers to gather feedback on usability and accessibility of the ePHR interface. Compliance checks will ensure adherence to health data standards and privacy regulations, as set by organizations like the European Commission and WHO. Finally, performance monitoring tools will be implemented to assess the platform's functionality post-deployment, ensuring it meets the specified requirements and user expectations. Through this structured approach, the aim is to enhance user experience and data security in healthcare services.

4 Validation Objectives

4.1 UC1: AI-Powered Posture Evaluation and Gait Analysis

4.1.1 Requirements

Requirements	Description
Cybersecurity, privacy and data protection	The Participant confidentiality will be maintained, and data always stored in pseudonymised format. In general: **Metrarc and Essex staff have no direct access to patient identifiable data captured in the cloud system. However, depending on study requirements (for eg. to test video quality) authorized access can be given.** **Open source data will be used to test communication systems.**
Location	Essex
Data availability and access	Data is only available to authorized personnel, established by access roles within the cloud platform
Communication	Electronic data transfer is made via a secure system, password protected and encrypted using software which meets a current industry standard, such as SSH, SSL, HTTPS etc. Where a suspected or actual data security breach occurs, the relevant parties are notified immediately.
Interoperability	Different apis will be provided for intercommunication with other systems
Performance	The system will be optimized to handle reasonable volumes of data and users in lab trials, ensuring that performance remains stable and responsive, even under increased load for AI function.
Technical requirements	The system will be developed using robust, scalable, and flexible technologies in the existing cloud service provider to ensure security, efficiency, and adaptability of AI service to future upgrades or expansions.

4.1.2 Key Performance Indicators

Key Performance Indicator	Target	Responsible Partners
Communication data size	Communication data size to be compressed at least 10% compared to original data	Brunel

Cloud environment setup for data capture	90% of staff members and users should be capable of logging in to environment and visualize data	Metrarc
Video Capture Success Rate	80% upload success; it should be possible to upload all videos, unless issues with network or server inaccessibility, in this case video will be stored on mobile device until its possible to upload	Metrarc
Usability	Greater than 3.5 out of 5 in satisfaction surveys given to each participant	Metrarc
System Uptime and Availability	80% uptime; running on dedicated servers, downtime due to configuration changes	Metrarc,Essex
Video Upload Time	Less than 2 minute for videos of length between 1 and 2 minutes	Metrarc
Video Analysis Turnaround Time	Video analysis should take less than 5 minutes for videos of length between 1 and 2 minutes	Essex
Video analysis accuracy	Root mean squared error (RMSE), and relative RMSE to capture the variable collected from markerless and optical systems should be less than 20%	Essex

4.1.3 Validation Criteria

Validation process will be led by Essex, and a lab based data collection and validation will be performed in the sport science motion capture lab. details of the validation process as follows:

- We will collect video data for both marker (ground truth) and markerless motion capture systems from at least 20- 30 health participants performing stand up and walk 3 meters, turn, walk back, and sit down. To our knowledge, this is the largest sample containing both marker and markerless motion data for rehabilitation exercises.
- Validation of the system will include testing using a lab trial with ground truth data, which will give a comprehensive evaluation of a low cost markerless system. Motion capture will be performed using our 14 camera Vicon system (100Hz), and using a phone that is fixed on a tripod. The iPhone will be placed at a distance sufficient to capture the whole body. Two angular positions of the phone will be tested - 45° and 90°, relative to the orientation of the participant.

Motor tasks: The following tasks will be assessed:

1. **Walking (5 trials for each speed)**
   - Self-paced speed
   - Self-determined “moderately fast” speed

- Self-determined “fast” speed

2. **Jogging (5 trials for each speed)**
   - Self-paced speed
   - Self-determined “moderately fast” speed
3. **Countermovement jump (5 trials)**
   - Maximal effort, self-selected depth

Each task and trial will be interspersed by 2 minutes of rest. For the walking and jogging tasks, participants will have a 5m lead-up distance for achieving constant speed, and a 5 m tail-off distance for deceleration from the force plate.

Statistical plan:

For each dependent variable of hip, knee, and ankle sagittal plane waveform angles, three statistical tests will be conducted: Pearson correlation, root mean squared error (RMSE), and relative RMSE to capture the variable collected from markerless and optical systems.

4.2 UC2: AI-based Depression Relapse Prediction Service

4.2.1 Requirements

Requirements	Description
Cybersecurity, privacy and data protection	Our data protection policy is based on respecting the right to privacy, applying the principle of minimization, and avoiding the collection of sensitive data unless permitted by applicable law. Legal justification for data processing is based on legitimate interests or explicit user consent. We ensure compliance with the General Data Protection Regulation (EU 2016/679), and data will only be shared with entities necessary to fulfill the stated purposes. In case of data transfers outside the European Economic Area, we comply with all legal requirements.
Location	Data will be stored in secure servers located within the European Union or in regions compliant with the GDPR and other applicable data protection regulations. If international transfers are required, they will adhere to all legal safeguards.
Data availability and access	Data will be accessible only to authorized users, with strong security measures like two-factor authentication and role-based access controls. Only those with proper authorization will have access to sensitive information.
Communication	All communication between the MobileApp, CentralApp, and any external services will be encrypted using secure protocols such as

	HTTPS and SSL/TLS, ensuring the integrity and confidentiality of the transmitted data.
Interoperability	The platform will be designed to ensure compatibility with external systems, facilitating data exchange and integration with other services or platforms as required.
Performance	The system will be optimized to handle large volumes of data and users, ensuring that performance remains stable and responsive, even under increased load.
Technical requirements	The system will be developed using robust, scalable, and flexible technologies to ensure security, efficiency, and adaptability to future upgrades or expansions.

4.2.2 Key Performance Indicators

Key Performance Indicator	Target	Responsible Partners
Adoption Rate of the Tool	Achieve 10% adoption in targeted schools within the first year	IDavinci, Horus, Impulso Cognitivo, Local Schools
Accuracy of Mood Change Detection	85% accuracy in detecting mood changes through voice and data markers	Horus, Impulso Cognitivo
User Engagement Rate	Ensure 75% of users complete all phases of surveys and data collection	IDavinci, Horus, Impulso Cognitivo, Local Schools
Data Security and Privacy Compliance	100% compliance with GDPR and other applicable data protection regulations	IDavinci
Machine Learning Model Improvement	Improve predictive model accuracy by 15% after each data training phase	Horus
Computation Time	Measure the computation time required to obtain depression probability per individual	Horus, IDavinci
Memory Usage	Measure the maximum RAM usage of the model to analyze the entire cohort	Horus, IDavinci
Prediction Error by Population Groups	Measure prediction error across different population groups to check for potential biases not justified by clinical literature	Horus, Impulso Cognitivo

4.2.3 Validation Criteria

The validation process will be led by IDavinci, with Impulso Cognitivo playing a crucial role in cognitive assessment, data collection, and the evaluation of depression-related data. Their expertise in evaluating executive functions and administering validated questionnaires to assess depressive symptoms will be instrumental. This will help in identifying adolescents at risk for depression, enabling early intervention and personalized support.
The primary goal is to validate the app/screening platform, including the pre-trained AI models. This validation will be conducted using the data obtained during the second data collection phase (T4.1). The effectiveness of the developed tool will be assessed by measuring its ability to accurately identify depressive symptoms and provide meaningful insights for early intervention. The platform validation will take place after the second round of data collection in task T4.1. This pilot test will be applied to a pilot group to identify potential issues or areas for improvement in the platform. These evaluations will help in refining the tool to ensure its validity and reliability before its full deployment. Any necessary adjustments identified during this phase will be incorporated into the platform. The ultimate goal is to deliver a precise and effective tool that supports comprehensive user evaluation.
The task will be performed by Impulso Cognitivo, but Horus ML will oversee the evaluation process, specifically focusing on the performance of the integrated machine learning models. Horus ML will provide expert support in analyzing the metrics obtained from the AI models to ensure the models function as expected.
Expected Results:

- Collection and analysis of key performance metrics from the tool.
- Final approval of the AI4TeenDep platform (milestone H1.2), confirming its readiness for full deployment.

4.3 UC3: Intensive Care Units (ICUs) Telemedicine System

4.3.1 Requirements

Requirements	Description
Cybersecurity, privacy and data protection	The system must include robust encryption, authentication methods, and data protection protocols to ensure the security of patient data. Patient privacy must be protected in accordance with legal regulations.
Location	The system should facilitate data flow between different intensive care units and remote healthcare service centers.
Data availability and access	Patients' health data and the telemedicine system must provide uninterrupted access. Data should be readily available to authorized users (doctors, nurses) at all times.
Communication	The system must have voice and video communication capabilities to enable healthcare professionals to effectively communicate with patients and each other.

Interoperability	The system must be compatible with other health information systems (EHR, lab systems, etc.) and support data exchange. Seamless integration between different devices and platforms should be ensured.
Performance	The system should be designed to demonstrate high performance and provide real-time data transmission. Additionally, it should offer a user-friendly interface and enhance the user experience.
Technical requirements	The system must comply with current software and hardware standards; it should be supported by high-speed internet connections, reliable server infrastructure, and necessary hardware (cameras, microphones, etc.).

4.3.2 Key Performance Indicators

Key Performance Indicator	Target	Responsible Partners
Data Security Incidents	0 incidents per quarter	Kafein
User Access Compliance	100% authorized access	Kafein
Real-time Monitoring Effectiveness	95% of threats detected and mitigated	Kafein
Compliance with Legal Regulations	100% compliance with GDPR and KVKK	Legalmatik
Data Collection Efficiency	Data collected quickly for efficient analysis and decision-making	Karel, Rasyomed
Integration Success Rate	90% successful integrations	Rasyomed
Data Availability	99% uptime of health data access	Rasyomed
User Satisfaction Rate	85% satisfaction score	All Partners

4.3.3 Validation Criteria

A variety of validation methods will be applied to ensure the successful implementation of the 5G4PHealth platform. Regular audits and incident reports will be conducted to ensure compliance with data security and privacy regulations, with a goal of zero data security incidents per quarter. For user access control, access logs will be reviewed, and random audits will be performed to achieve 100% authorized access. Real-time monitoring of cybersecurity threats will utilize monitoring tools to evaluate response times to detected threats, aiming to detect and mitigate 95% of threats. Performance tests will be conducted to ensure that health data is collected within 5 minutes per device and is accessible 99% of the time. Integration success will be enhanced through integration testing, with successful data exchanges documented to achieve a 90% success rate. User satisfaction will be assessed through User Acceptance Testing (UAT) sessions, aiming for a satisfaction rate above 85%. Finally, compliance audits will be carried out to ensure adherence to health data standards as set by organizations like the European Commission and WHO. Through these methods, the performance and security of the 5G4PHealth platform will be enhanced.

Also, the central service must be designed, developed, and established in accordance with HL7 (Health Level Seven) standards applicable to the healthcare sector. This service should facilitate data exchange among healthcare institutions while ensuring compliance with communication protocols. Additionally, a suitable testing environment must be designed and prepared for testing and developing healthcare IT systems in hospitals, allowing for risk-free testing of new features, updates, and integrations.

- The project team will understand HL7 standards and the requirements in the healthcare sector.
- Identify and analyze the requirements for the central service.
- Be knowledgeable about HL7 messaging and integration protocols.
- Ensure the proper processing and transmission of data received from healthcare institutions.
- The project team will understand hospital business processes and requirements
- Identify and analyze the requirements for the testing environment.
- Prepare test data, simulations, and test scenarios.
- Define the hardware and software requirements for the testing environment.

5 Future Work

The definition of the validation strategy and the implementation process for each use case has shown satisfactory progress for all use cases.
All validation requirements and the overall test methodology have been outlined, providing a strong foundation for the subsequent phases of the project. However, it is important to note that certain aspects of the validation strategy, such as detailed test descriptions and procedural elements, are subject to refinement as we advance through the project's implementation stages. These adjustments will be made in response to ongoing findings and the practicalities of integrating the 5G4PHealth platform components.
Looking ahead, the 5G4PHealth consortium will focus on starting the integration, testing, and evaluation of the use cases across the pilot sites. The project's second half will involve extensive testing in real-world healthcare environments to validate the platform's performance, security, and usability under various conditions. Our objective is to complete the validation activities for all use cases and deliver fully functional demonstrations, supported by detailed results.

In the upcoming months, we will also address any requirements that remain uncovered or partially addressed in this report. Further efforts will be directed towards expanding the capabilities of the current solutions to support additional functionalities and features based on stakeholder feedback and pilot testing outcomes.
Our ultimate goal is to provide a comprehensive Pilots result assessment and evaluation report that encompasses all aspects of the 5G4PHealth platform's performance, scalability, and impact on healthcare delivery. This report will showcase the effectiveness of the platform and its potential to transform healthcare through advanced 5G-powered solutions and patient-centered innovations.

6 Conclusion

Deliverable D2.2 "Use Case Specification, Requirements Elicitation, KPIs, and Validation Plan" provides a comprehensive framework for the specification and validation of the 5G4PHealth use cases, incorporating detailed requirements analysis and a structured methodology for validation. The document captures the outcomes of Task 2.1 and Task 2.2, focusing on gathering use case requirements, defining specifications, and establishing Key Performance Indicators (KPIs) that will guide the project's evaluation and ensure alignment with its objectives.
We presented an in-depth description of each use case, highlighting the functionalities, user scenarios, and expected impact on healthcare services. The validation strategy detailed in this deliverable outlines the test methodologies and success criteria for each use case, enabling a thorough assessment of the platform's performance, security, and usability. This proactive approach to validation will support effective decision-making throughout the implementation phase and help identify potential issues early on.
One of the core considerations in the 5G4PHealth platform is ensuring the protection of personal and sensitive health information. To this end, compliance with relevant privacy regulations such as GDPR is prioritized through measures including data anonymization, encryption, and secure communication protocols. The platform adheres to industry best practices for data security and privacy, ensuring that patient data is handled with the highest standards of care and confidentiality.This deliverable has identified several key elements and strategies that will be further refined and expanded in future work packages. During the second phase of the project, the 5G4PHealth consortium will delve deeper into the technical specifications and validation methodologies for each use case, ensuring a robust and effective implementation process. Through this approach, we aim to ensure that the 5G4PHealth platform not only meets but exceeds expectations in delivering innovative, reliable, and secure healthcare solutions powered by 5G technology.