D4.3.2: APPLICATION/SOFTWARE DEVELOPMENT
(ICT Project Manager)

«Report on the coordination activities of the Design and Development of the Healthcare Monitoring system»

Reporting period: 20/09/2018 - 30/08/2020

WP 4 Joint Monitoring System

project

IMPROVING HEALTHCARE ACCESS THROUGH A PERSONAL HEALTH MONITORING SYSTEM

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http://www.ehealthmonitoring.eu/

Summary

The deliverable «Report on the coordination activities of the Design and Development of the Healthcare Monitoring system» is part of the project APPLICATION/ SOFTWARE DEVELOPMENT within the frame of WP 4 Joint Monitoring System of the project IMPROVING HEALTHCARE ACCESS TROUGH A PERSONAL HEALTH MONITORING SYSTEM, according to our contract (14/09/2018 – Ref. No: 44959) and is being implemented within the framework of the Programme INTERREG V-A Greece – Boulgaria 2014-2020.

The particular deliverable aims to highlight the activities performed within the period 20/09/2018 - 30/08/2020 concerning the coordination of the project team for the design and development of the Healthcare Monitoring System. The document describes the procedures and results of the work followed and the tools used to coordinate the design and development activities of the Health Monitoring System by the implementation team. In this phase of the project, the system architecture was finalized, design improvements were made and the development of additional functions was completed, while special emphasis was placed on ensuring the security of the system and enhancing its usability and acceptance by end users.

Table of Contents

1 Introduction

This deliverable concerns the coordination of the design and development works of the Health Monitoring System for the period 20/09/2018 - 30/08/2020. In this phase of the project, the final improvements were made in the design of the information system for recording and processing of biosignals and in the management of health data, the implementation of the system functions was completed, by extending some of the existing ones and the supported scenarios were defined in detail and in a standardized way. use.

Overall, the services designed, developed and integrated into the original system offer the following capabilities:

- Contact management
- Communication of the user (via video) with the medical staff and relatives
- Recording the following parameters regarding the health and physical state of the user:
  - Oxygen Saturation Level (SpO2)
  - Heart rate
  - Arterial pressure
  - Glucose level
  - Daily physical activity (number of steps and sleep time)
- Electronic Health Record that incorporates historical measurements of the aforementioned parameters, as well as additional data, such as lab results, medication and allergies
- Visualization of the records of the above parameters and remote access to doctors, upon the user's authorization
- Automatic detection of deviations from predefined limits for the above parameters and notification of medical personnel
- Development of a personalized treatment schedule for each patient
- Smart reminders that encourage patient adherence
- Photo sharing between contacts
- Automated weekly patient reports
- Export medical history in pdf
- Doctor's notes functionality

The services are addressed to chronic sufferers, people recovering post-operatively or in rehabilitation, as well as individuals (possibly elderly) who live independently and need communication or support in their daily needs and activities, especially in the case of people residing in isolated areas and do not have direct access to health services.

The above functionalities of the system are designed taking into account the conclusions drawn from the feasibility study. In particular, the system is designed with flexibility in place, so that it can be deployed in both participating countries and in other countries in the future, without the need for substantial modifications to the hardware used and with limited additional investment in software and business development. To this end, the use of well-established standards for the creation of an interoperable solution that leverages existing reliable sensor and medical data management technologies to create new innovative models of health care delivery was crucial.

In addition, the development of the cloud computing platform and in particular the APIs that support the various functionalities of the user applications (web and mobile app) was completed, while significant improvements were made in the functionality of video calling and the use of the WebRTC protocol. In addition, the mobile application was redeveloped almost from scratch using Flutter, with the aim of creating a cross platform solution, allowing the easy development of the mobile application for iOS devices in the future.

The system security study and the integration of the relevant policies and mechanisms were also carried out. The objectives of the security system are summarized in the acronym CIA (Confidentiality, Integrity and Availability), while special attention was paid to compliance with the requirements of the GDPR. More specifically, the requirements regarding the security and confidentiality of the data were recorded in detail, and the information system security study was prepared, which analyzes the characteristics of the security system, the relevant roles and the proposed procedures for detecting and managing security incidents.

Finally, during this period, special attention was paid to the evaluation and improvement of the usability of the system, as a determining factor for its acceptance by end users. In this context, an extensive study of the relevant literature was carried out in order to record the basic principles of user interface design with increased usability requirements, taking into account the special needs of the end-user target group, which includes the elderly, people with sensory impairments (e.g. x. reduced vision), but also generally people unfamiliar with technology. Based on these principles, modifications were made to the user interface, where necessary. To validate the effectiveness of these interventions, an evaluation of the usability of the system was carried out with the participation of a sample of potential end users.

2 Objectives and Activities

During the reporting period, the objectives of the design and development of the Health Monitoring System were as follows:

- Development of the final version of the operational prototype of the Health Monitoring System

- Completion of the implementation of the planned functions

- Complete the design of the platform and the various mechanisms that support system functionality (APIs)

- Detailed and standardized recording of all supported usage scenarios

- Improving end-user interfaces in web and mobile environments and ensuring an increased level of usability

- Development of functions that allow the most effective monitoring of patients by the treating physicians, such as the function of automatic weekly reports

- Creation of the appropriate infrastructure for the future expansion of the system facilitating the development of the end user application in an iOS environment

- Ensure compliance of the system with European legislation on the protection of personal data, integration of mechanisms that enhance security and protect the privacy of users and recording of proposed procedures for the management of security incidents

Along with development activities, additional activities were carried out, which include:

- Completion of the feasibility study, which contributes significantly to the system design strategy and its future utilization

- Literature review and study of good design practices in order to ensure a high level of usability of the system and its evaluation with valid tools

- Continuous testing to check the proper operation of the system, but also to ensure its reliability and the satisfaction of operational and non-operational requirements.

3 Infrastructure

3.1 Cloud infrastructure

Okeanos has been selected for hosting the eHealth Monitoring platform and its various components. Okeanos is an environment that provides high quality virtual infrastructure (computers, network, storage) to the Greek Academic and Research Community and is designed and developed by the National Research and Technology Network (GRNET) for the benefit of the Greek academic community.

okeanos dashboard

Overview   Profile   API access   Usage   Projects   Contact

ehealthmonitoring.eu   PROJECT ACTIVE
MODIFY - LEAVE

PROJECT DETAILS

Name	ehealthmonitoring.eu
Homepage url	http://ehealthmonitoring.eu/
Description	Το έργο EHEALTH MONITORING στοχεύει στη βελτίωση της δημόσιας υγείας και της ποιότητας ζωής των πολιτών, υιοθετώντας τεχνολογίες οι οποίες προσαρμόζονται στις προσωπικές ανάγκες και συγχρόνως είναι αυξημένης αξιοπιστίας και μειωμένου κόστους. Το έργο συγχρηματοδοτείται από το πρόγραμμα συνεργασίας Ελλάδας – Βουλγαρίας Interreg V-A 2014-2020, το οποίο είναι ένα πρόγραμμα διασυνοριακής συνεργασίας που συγχρηματοδοτείται από την Ευρωπαϊκή Ένωση στο πλαίσιο του Ευρωπαϊκού Ταμείου Περιφερειακής Ανάπτυξης.
Creation date	13/05/2019
End Date	31/12/2020
Owner	Me

RESOURCES

	Max per member	Total	Usage
File Storage Space	20.0 GB	20.0 GB	0% (0 bytes)
Hard Disk Storage	50.0 GB	50.0 GB	40% (20.0 GB)
CPUs	8	8	50% (4)
RAM	16.0 GB	16.0 GB	50% (8.00 GB)
VMs	2	2	50% (1)
Private Networks	2	2	0% (0)
Public IPs	2	2	50% (1)

1 Okeanos dashboard

3.2   Project team

The design and implementation project team consists of persons that cover a wide range of experience and know-how related with the project services. The project team consists of the following:

- Nikolaos Markellos
- Georgios Pistikos
- Vasileios Mitsios
- Sotirios Serdenis
- Soultana Toumpalidou

3.3   Development tools and technologies

3.3.1   Web platform

The following technologies were used to develop the Health Monitoring System platform as well as the end-user web application:

- JavaScript
- TypeScript
- MEAN Stack, which consists of:
  - MongoDB
  - Express
  - Angular
  - Node.js

3.3.2   Mobile app

The following technologies were used to develop the mobile application of the Health Monitoring System:

- Java
- Android
- Bluetooth Low Energy Protocol (BLE)

In addition, the following technologies were utilized during this period:

- Flutter: Flutter is an open source framework, created by Google, that aims to create cross platform applications (same application running on different platforms - eg Android, iOS). The difference from other similar tools (such as React Native) is that Flutter generates source code for each platform on which the application will run, allowing the developer to use both Dart - Flutter's high-level language - as well. and the languages of each platform for more specialized functions.

- Dart: This language, which is very similar to JavaScript, provides all the basic tools of an object-oriented programming language. Third-party libraries have been used to achieve several functions, while the implementation of functions in native code (ie in code of a specific platform) has not been avoided.
- Flutter libraries
  - o Get Navigator: Library to support screen transitions (default transitions are problematic and cumbersome)
  - o Flutter WebRTC Plugin: Library to support WebRTC calls. Data exchange is done with WebSockets.
  - o Flutter Charts: Library for displaying charts
  - o FlutterBlue: Library to support Bluetooth devices

The platform language used is Java (for Android), while in the future Swift can be used to implement the application on iOS.

In addition, the following technologies that support security mechanisms have been used:

- Sembast: With the Sembast library the local data of the application is saved. This library supports encryption through a codec which is generated by a code given by the developer.
- Shared Preferences: The Shared Preferences library uses NSUserDefaults on iOS and SharedPreferences on Android. It stores more sensitive data (such as access token, login token) etc.

3.3.3   Database

The following technologies were used for the system's database:

- MariaDB
- MySQL
- Redis

3.3.4   Server

For the various background applications of the system, the following technologies were used:

- Python
- Web Services & RESTful API
- JSON
- WebSocket

In addition, the following technologies were used for the operation of push notifications:

- Firebase Cloud Messaging: Firebase Cloud Messaging (FCM), formerly known as Google Cloud Messaging (GCM), is a multi-platform messaging and alerting solution for Android, iOS, and web applications that is currently free. The service is provided by Firebase, a subsidiary of Google.

- PushKit: The PushKit tool supports specialized alerts for updating WatchOS complications, responding to changes in the file provider, and receiving incoming Voice-over-IP (VoIP) calls.

- User Notifications Service: Apple's messaging and notifications service.

3.3.5 Other Technologies

Some additional technologies used to develop the Health Monitoring System platform and to conduct testing activities are the following:

- Gradle

- Git

- Docker (Container)

- WebRTC

4 Management

This section describes the managerial issues of design and development tasks such as priorities and milestones, deliverables, and time plan.

4.1 Priorities

During the reporting period, the priorities for the strategic coordination of system design and development work are summarized as follows:

- Fulfillment of functional and non-functional requirements

- Enrichment of the system capabilities with new useful functionalities

- Integration of the conclusions of the feasibility study in the design of the system

- Creation of appropriate infrastructure for future expansion of the system in iOS environment

- Ensuring a high level of system usability, by improving and evaluating the user interface and by studying the process of familiarizing the end users with the system• Providing support to the Greek pilot contractor and rapid response to requests for technical support in order to quickly correct errors and complete improvements deemed necessary, in order to maximize the acceptance of the system by users

- Compliance of the system with the legislation on personal data protection and strengthening of its security

The following is a breakdown of the work coordination methodology, activities and deliverables that have been developed, contributing to the achievement of the above objectives as well as the project objectives. In addition, some tools for monitoring the progress of the project and the timetable for implementation are presented.

4.2 Methodology

The methodology followed during the design and development activities combines innovative, established project design and implementation methodologies such as the 'waterfall' methodology during the early stages of the project and the 'agile' method (agile) at the stage when the pilot testing of the project will begin. The combination of these methods aims to adapt the functions and capabilities of the system as they can change significantly during project implementation.
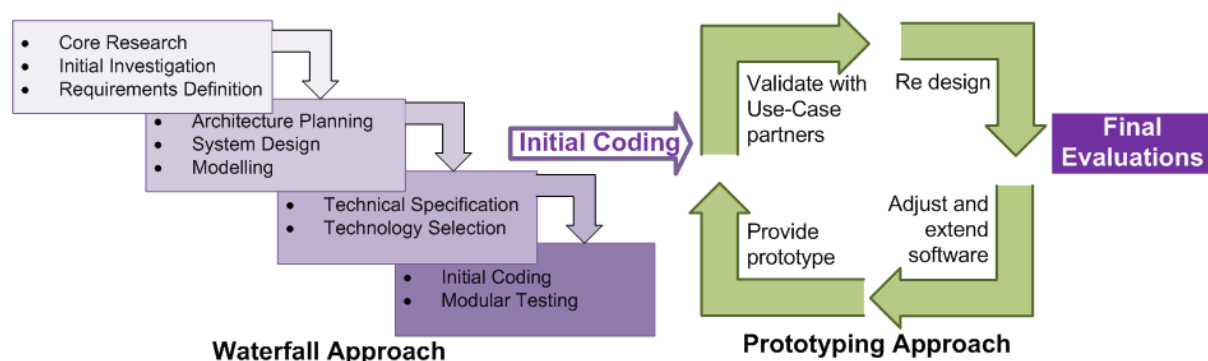
2 Methodology

The use of the above methodologies allows for better design of the prototype by gradually developing applications that meet the maximum of user requirements. The work related to this deliverable refers to the stage of developing the system prototype.

In order to improve and evaluate the usability of the system, two new methodological tools were used. Initially, the usage scenarios of the system were recorded with the logic of user journey. User journeys (often referred to in the literature as customer journeys) describe the sequence of actions that users take as they begin to use a software or service, starting with introductory use and moving on to more advanced and / or specialized functions. Along with each stage of familiarization, the user journey diagrams describe the corresponding phases of the user experience (user experience) and especially the feelings and thoughts or opinions of the user as he moves from one phase to the next - the idea is that the design of application must take into account not only the functionality, but also the user experience and guide it through its successive phases.

For the usability evaluation of the system, the System Usability Scale method was used, which includes the collection of quantitative data through a questionnaire. This provided us with a quick overview of the overall design of the end-user application, as well as some indications of issues that remain unresolved. The SUS questionnaire is based on a Likert psychometric scale and consists of 10

questions, which can provide a high level of subjective evaluation for the usability of the system. We chose the SUS questionnaire because it can be used in a variety of products and services, including software applications, mobile applications, consumer hardware products and other types of systems, as it is independent of the technology under evaluation and has been used to evaluate telecommunication systems. -health. In addition, it is available for free, it is an economical method of implementation, and also easy for study participants. Most importantly, it has been found that SUS is valid and extremely reliable, while there is a certified translation into Greek.

4.3 Milestones

The key milestones for the development of the system, as well as their duration, are presented in the table below. Milestones are defined by the various subtasks.

Activity	Responsible
Feasibility Study – Go-to-Market Strategy	Sotirios Serdenis
Finalisation of information System design	Georgios Pistikos
Definition of Information Security Policy	
Development and documentation of APIs	
Deployment and documentation of all use cases	Vasileios Mitsios
Development of cross platform solution for mobile app	
User interface improvement	
Functionality testing	Soultana Toumpalidou
Usability evaluation	

4.4 Monitoring of the activities

The following tools were used to coordinate and monitor the various tasks:

- GitLab
- Trello
- Slack
- Notion

Coordination of the team effort follows a weekly planning process, with meetings of directly collaborating members, and meetings of the entire team on a monthly basis at least. The software version of the platform is also updated on a weekly basis. The activities coordinator is responsible for monitoring the progress of the tasks of the software development phase and maintaining the timetable, as well as to take appropriate corrective action if this is not observed.

5 Deliverables

5.1 Deliverable «Healthcare monitoring system design»

This deliverable presents the final version of the system architecture. In addition, the key requirements for the security, confidentiality and integrity of sensitive personal data, user certification, and compliance with national and Community legislation were analyzed. Finally, the Security Policy and the technical and organizational characteristics of the Security System are recorded in the deliverable.

5.2 Deliverable «Healthcare Monitoring System Development»

The deliverable describes the system as a whole and the functionalities it offers. Specifically, the new system functions are described and all supported use case scenarios are documented in a formalized way. In addition, technical and security features of the application are reported.

5.3 Deliverable «Feasibility Study of the Healthcare Monitoring System»

This deliverable is the last part of the feasibility study of the project and presents the results of the third phase of the feasibility study of the planned system and the relevant research. Following the first phase, in which the expected benefits were analyzed, as well as the market to which the Health Monitoring System implemented by the project is addressed, and the second phase, during which examples of good practices in the digitization of health services were examined and In Europe, the third phase of the study analyzes the proposed go-to-market and value generation chain. From the elaboration of this study, useful guidelines emerged for the formulation of the requirements and specifications of the Health Monitoring System, but also for its implementation, both in the context of the pilot tests of the project and in its subsequent utilization.

5.4 Deliverable «Testing report of the Healthcare Monitoring System»

In parallel with the development processes of the system, the functionality of the individual subsystems was constantly tested, for the timely detection and correction of errors and failures in the implementation. The relevant deliverable focuses on the quality control of the mobile application of the system in terms of usability level and user friendliness. As the Health Monitoring System is meant to be used by users with different backgrounds and levels of technological skills, usability is a key parameter in the design of application interfaces and its evaluation and improvement is necessary to ensure the viability of the system and its acceptance by end users. The document describes the relevant usability principles adopted, as well as the method and tools for evaluating their effectiveness.