



Department of Economics
Democritus University of Thrace

Interreg
Greece-Bulgaria
eHealth Monitoring
European Regional Development Fund



D4.3.2: APPLICATION/SOFTWARE DEVELOPMENT (Quality Assurance Manager)

«Testing report 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

Soultana – Anna Toumpalidou

August 2020

The project is implemented in the framework of INTERREG V-A “Greece-Bulgaria 2014-2020” Cooperation Programme and is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Programme

<http://www.ehealthmonitoring.eu/>

The contents of this publication are sole responsibility of project partners and can in no way be taken to reflect the views of the European Union, the participating countries, the Managing Authority and the Joint Secretariat

Summary

The deliverable «Testing report of the Healthcare Monitoring System» is part of the project APPLICATION/ SOFTWARE DEVELOPMENT in the frame of WP 4 Joint Monitoring System of the overall project IMPROVING HEALTHCARE ACCESS THROUGH A PERSONAL HEALTH MONITORING SYSTEM, according to the contract (14/09/2018, Ref. No: 44958) that is being implemented under the INTERREG V-A Greece – Bulgaria 2014-2020 Programme.

This deliverable refers to the period 20/09/2018 - 30/08/2020 and describes the methods, tools and the results of the testing procedure of the eHealth platform (and its subsystems) along with the necessary activities for the software updates and the Version Control. Furthermore, it focuses on the quality control of the mobile application of the system in terms of usability level and user friendliness. As the Integrated Health Monitoring System is meant to be used by users with different backgrounds and level 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.

Table of Contents

Summary	2
Table of Contents	3
List of Figures	3
1 Introduction	4
2 Testing, Control and Usability Guidelines	5
2.1 Methodology	5
2.1.1 Black-box testing	5
2.1.2 Automated Testing	6
2.2 Report Management and Release Control Tools	6
2.3 Tickets	6
2.4 Usability Guidelines	18
3 Usability Evaluation	21
3.1 Usability Evaluation Methods	21
3.2 System Usability Scale	21
3.3 Evaluation Methodology	23
4 Evaluation Results	25
5 Conclusions	27
6 References	28

List of Figures

Figure 1: The initial interface that the patient sees after logging in to the Android application	19
Figure 2: The options a patient sees when choosing to see his or her history.	20
Figure 3 SUS Questionnaire	22
Figure 4 SUS % Scores	23
Figure 5 SUS Descriptive Scores	23
Figure 6 SUS Scores Distribution	25
Figure 7 SUS Answer Frequencies	25

1 Introduction

The main purpose of the project is to ensure the provision of health services to people who do not yet have access, through the development and pilot testing of a digital system that allows remote medical monitoring. The main goal of the services provided is to improve the standard of living of the chronically ill with diseases such as diabetes, hypertension, heart disease and chronic obstructive pulmonary disease, but also to enhance the well-being and self-management of citizens' health, with the ultimate goal of positive benefits for society as a whole, but also the Public Health System.

In our time, the adoption of technology becomes imperative, as it is a dominant and integral part of our society, widespread in all areas of life. As the world's population ages and older people make up a growing share of the population of industrial societies, research into the benefits that older people can enjoy from adopting modern technologies is becoming increasingly important. Tele-health technology applications, such as Medical Monitoring Systems, in addition to providing health services and supporting their independent living, are able to reduce the huge costs of treating the elderly and chronic diseases in national health care systems.

As a result, such technologies are becoming increasingly popular, leading to significant research into the development of innovative applications. Indeed, many older adults recognize the potential benefits and express their willingness to adopt such technologies. However, in order for seniors to embrace and adopt new applications, technology must not only satisfy a need, but also be perceived as useful.

Significant research has been conducted to identify and understand the various limitations faced by older users, as well as users with reduced technological skills in general, when presented with modern ICT technologies, with the most important being accessibility and physical limitations (e.g. e.g., vision problems). Specific rules have been proposed by several researchers to address these limitations. However, there are additional psychological barriers that need to be considered (eg lack of confidence, hesitation and anxiety) every time users are introduced to ICT applications. In addition, certain environmental factors (eg lack of support from family members) also play an important role.

The rest of the deliverables are structured as follows: Chapter 2 presents the testing and control, as well as the usability principles adopted during the design of the interfaces of the application of the Medical Monitoring System, based on an extensive literature review. Chapter 3 presents the methodology of quantitative and qualitative evaluation of the usability of the system by potential end users. Chapter 4 presents and interprets the results of the evaluation. Finally, some recommendations for future improvements are provided.

2 Testing, Control and Usability Guidelines

2.1 Methodology

Testing is aimed at extracting information about the quality of the product or service being tested. The tests also provide an objective and independent view of the software, allowing the company to understand implementation problems early and prevent risks. Testing techniques usually involve running a program or application to detect software bugs. Software testing examines the system with respect to the following properties:

- meets functional and non-functional requirements
- correctly responds to all possible inputs
- performs its functions in an acceptable time
- is reasonably easy to use
- can be installed and run in the intended environment
- achieves the result that its users want

Since the number of possible tests, even for simple systems, is practically infinite, the software control process is based on a selection strategy for specific tests, which will be feasible based on time and resources. Of course, the testing process is repetitive, as resolving an error can lead to other, more profound problems or even to create new ones.

2.1.1 Black-box testing

The method followed by the testing group for testing the Biorax platform and the individual applications is Black-box testing. This is a test method that examines the functionality of the application without requiring knowledge of the internal structure of the system.

In the early stages of the platform development, the main objective of which was to identify significant errors and to confirm the correct implementation of the basic functions of the system, the tests were based on the execution of standard test cases. By increasing the complexity and the maturation of the system, the scenarios began to become much more complex, increasingly approaching the actual conditions of use of the platform.

The tests on the platform were performed by using the following technologies and tools:

- Mocha.js - <https://mochajs.org>
- Chai.js – <https://www.chaijs.com>
- Expect.js - <https://github.com/Automattic/expect.js>

2.1.2 Automated Testing

Secondarily, the Selenium software control tool for automated testing was used. Selenium is a test software platform for web applications. It provides a recording / playback function that allows for test without knowing a programming language (Selenium IDE). It is mainly used in automation of web applications for testing.

2.2 Report Management and Release Control Tools

Recording and managing reports for the errors detected during the tests was done using the following tools, which were also used for version control.

- **Comidor¹:** Comidor is a SaaS tool for small and medium-sized businesses, which acts as a staff collaboration platform and provides communication capabilities (email, internal messaging), tools for planning, organizing and controlling all business processes, and organizing business records.
- **GitLab²:** Git is an open source version control system. GitLab is a web-based management tool based on git, which additionally provides tools for recording tracking.

2.3 Tickets

The following table lists all errors resulting from the test procedure that have been fixed or remain open.

Status	Title	Important	Status
Error	Adding an allergy does not work, nor does it show me suggestions as I type.	NO	Fixed
Upgrade	Back buttons on Android app	NO	Fixed
Error	Exception during installation	NO	Fixed
Error	Reminders for biosigned measurements	YES	Fixed
Upgrade	Sort contacts στη mobile	NO	Fixed
Upgrade	Icon for biosignals parameters	NO	Fixed
Error	Wrong language	NO	Fixed
Error	Drop down on the registration form	NO	Fixed

¹ <https://www.comidor.com/>

² <https://about.gitlab.com/>

Error	All dropdown sorting alphabetically and categorization	YES	Fixed
Upgrade	For contacts, let the phone not be required to sign up.	NO	Fixed
Upgrade	Mute to video call	NO	Fixed
Error	Session Killed by server	NO	Fixed
Upgrade	Send reminder to native so as to trigger pebble notification	YES	Fixed
Error	Mesurement service does not store the Blood pressure data	YES	Fixed
Upgrade	Reminders Categories	YES	Fixed
Error	The most recent alerts are at the top of the list.	NO	Fixed
Upgrade	Change layout to lite version	YES	Fixed
Error	Add a tablet reminder	YES	Fixed
Upgrade	Automatically return to the home screen	NO	Fixed
Error	Email confirmation from tablets	YES	Fixed
Upgrade	Add profile photo from mobile	NO	Fixed
Upgrade	Pop-up messages	NO	Fixed
Error	The dropdown on the registration form does not work on all devices	YES	Fixed
Upgrade	Complete registration on tablet	NO	Fixed
Error	Registration Token	NO	Fixed
Upgrade	Start application and change user	YES	Fixed
Error	New layout	NO	Fixed
Upgrade	Version number in lowercase, in the middle of the splash screen	NO	Fixed
Error	Wrong icon	NO	Fixed
Error	User registration from android app	YES	Fixed
Error	The invitation accept link does not work	YES	Fixed
Error	Threshold overruns alerts are not sent	YES	Fixed
Error	Corrections to delete an account from a helpdesk	NO	Fixed

Upgrade	Origin of medical examinations	YES	Fixed
Error	Entry of all examinations. Categorized	NO	Open
Error	Transfer user list storage internally to the application and not to the bioassist folder	NO	Fixed
Error	Changing biosignals from mobile does not change the indication that it has been registered manually	NO	Fixed
Error	Fields in bio-signals show values as decimal, while they are integers.	NO	Fixed
Error	Entry of all examinations. Categorized	NO	Open
Error	Error after call termination	YES	Fixed
Error	Large contact photos	YES	Fixed
Error	The offline icon appears instead of the photo	NO	Fixed
Error	Redirect after email confirmation	NO	Fixed
Error	The service for the measurements returns 200 even if it is wrong.	NO	Fixed
Upgrade	Introduction serious games	NO	Open
Upgrade	Introduction serious games	NO	Open
Error	Editing measurements by a doctor	NO	Fixed
Error	Message when the caller is in trouble and restarts	NO	Fixed
Error	Contact List - Huge Photo	NO	Fixed
Upgrade	List of allergens	NO	Fixed
Error	Drug search	NO	Fixed
Error	Exam Board Columns	NO	Fixed
Upgrade	The temperature and weather are also displayed on top of the button on the home screen.	NO	Fixed
Upgrade	Hide photo from desktop	NO	Fixed
Upgrade	Restart after application update	NO	Fixed

Upgrade	Restart app from helpdesk command	NO	Fixed
Error	The return button from creating / editing a reminder on mobile is in English	NO	Fixed
Error	Restore to full screen after volume change	NO	Fixed
Error	The device does not stay on when push notification is started.	YES	Fixed
Error	The application keeps the device open for ordinary users	YES	Fixed
Upgrade	Input pressure measurement automatic conversion of 15.5 to 155	NO	Fixed
Upgrade	Delete / Edit Biosignals	YES	Fixed
Error	User seems to be online while is offline	YES	Fixed
Error	The video off button is in English	NO	Fixed
Error	Too many messages in the desktop are in English	NO	Fixed
Upgrade	Actions of the link in invitation email	NO	Fixed
Error	Sugars do not show the measurements	YES	Fixed
Upgrade	Limits in historical and red if it has passed the limit	NO	Fixed
Error	History on mobile is missing names from the price columns and the "sprocket" on the right	NO	Fixed
Error	Change row in the list of online contacts	NO	Fixed
Upgrade	Communicate only with a computer microphone	NO	Fixed
Upgrade	Adding weight to biosignals	NO	Fixed
Upgrade	Automatic start of application ONLY for patients	NO	Fixed
Upgrade	Show doctors' boundaries within biosignals graphics	NO	Fixed
Upgrade	Live streams come out of biosignals. Default 1 week	YES	Fixed
Upgrade	In the android history we must also show the allergies and drugs	NO	Fixed
Error	The doctor can only change the patient's allergies and medications he has added	NO	Fixed

Error	Service call returns user list	YES	Fixed
Error	Cache problems. Old icons still appear after the web content update	YES	Fixed
Upgrade	Upgrade a simple member to a Doctor from HelpDesk	YES	Fixed
Error	Button in English	YES	Fixed
Error	Button in English	YES	Fixed
Upgrade	Repeated reminders	NO	Programmed
Upgrade	Icon for push notifications	NO	Fixed
Error	Image Disable Button	NO	Fixed
Error	Return from Biosignal Light View	NO	Fixed
Upgrade	Repeated reminders	NO	Programmed
Error	Closing screensaver	NO	Fixed
Error	Scroll Down on the photos	NO	Fixed
Error	Correction of message	NO	Fixed
Upgrade	Push notification for reminders/alerts	NO	Open
Error	Move the "Back" button from the 1st navbar to the 2nd navbar	NO	Fixed
Upgrade	Push notification for reminders/alerts	NO	Open
Error	Problem in Calling Calls	NO	Fixed
Upgrade	reminders sound	NO	Fixed
Upgrade	profile photo	NO	Fixed
Upgrade	Load EHR after registration or membership update	YES	Fixed
Error	Camera hits after a few calls	YES	Fixed
Error	Logout Button at mobile	YES	Fixed
Upgrade	Trial Period	NO	Open
Upgrade	Call button from the patient's tab	YES	Fixed
Error	Data Synchronization with Biomedicine	YES	Fixed
Error	Do not show results in the history that have no value	NO	Fixed

Error	Return Full Screen after typing	YES	Fixed
Error	History typing displays dashes	YES	Fixed
Upgrade	Deleting the connection control button when I add a user	YES	Fixed
Upgrade	Javascript popup messages need to become native android.	YES	Fixed
Upgrade	Trial Period	NO	Open
Upgrade	Simple Daily questionnaire on how the patient feels	YES	Fixed
Upgrade	Exams not coming from Biomedicine	YES	Fixed
Error	Double-click on an incoming call	NO	Fixed
Upgrade	Video	NO	Open
Upgrade	Voice reminders	NO	Open
Upgrade	Contact photos are not displayed immediately	NO	Fixed
Upgrade	Video	NO	Open
Upgrade	Voice reminders	NO	Open
Upgrade	Sorting History	YES	Fixed
Upgrade	Video (De)Activation Button	NO	Fixed
Upgrade	Measurement process	YES	Fixed
Error	Invitation call (mail - push notification)	YES	Fixed
Error	Push notification message	YES	Fixed
Error	Survey result	YES	Fixed
Error	Change automatic answer setting	NO	Fixed
Error	Manual measurement submission - Check limits	YES	Fixed
Error	Alerts for contacts reminders	NO	Fixed
Error	When the application is in the background, it rings, but it does not come to the fore	YES	Fixed
Upgrade	Chatting during video	NO	Open
Upgrade	Chatting during video	NO	Open
Error	Different messages depending on the user's gender	NO	Fixed

Upgrade	New biosignals	YES	Fixed
Upgrade	The application disables the keyboard prediction mode	NO	Fixed
Upgrade	Search users by name	YES	Fixed
Upgrade	Time limit when a user calls someone else and the other does not answer.	NO	Fixed
Upgrade	Call from initiation to contact that is offline	NO	Fixed
Upgrade	Add contacts during registration	NO	Fixed
Upgrade	Send a call for a user account	NO	Fixed
Upgrade	Call confirmation message	NO	Fixed
Upgrade	In the video chat between two users, it is advisable to include the name of the caller and Mr	NO	Fixed
Upgrade	Confirm Dialog to change the "favorite" contact	NO	Fixed
Error	Turning on / off the video causes changes to the UI	YES	Fixed
Error	Multiple push notifications	YES	Fixed
Error	JavaScript Console Error	NO	Fixed
Upgrade	Single User Registration from mobile just downloaded	NO	Fixed
Upgrade	Weather on the screensaver and the mobile web	NO	Fixed
Error	When I add a metric to the web application, refresh the charts automatically	NO	Fixed
Error	The autologin when I have a single user to slow longer because I can not add another user	NO	Fixed
Upgrade	Updating the weight on the patient's tab of the bio-signals	NO	Fixed
Upgrade	Only 2 contacts with auto answer;	YES	Fixed
Error	Check credentials when adding an account	NO	Fixed
Error	Contact photos in your doctor's application appear a little strange.	NO	Fixed
Error	The sound at every touch on the mobile does not play anymore.	NO	Fixed

Upgrade	Events in our member accounts have a serial number.	NO	Fixed
Upgrade	Biosignal origin	NO	Fixed
Upgrade	Restart when the camera crashes	NO	Fixed
Error	Slow webview entry	YES	Fixed
Error	When the user does not have a profile pic, a default user pic is displayed instead of white	NO	Fixed
Error	Typeahead at dropdowns	NO	Fixed
Error	Pop up to reconnect to the web is in English	NO	Fixed
Error	Text down right to leave	NO	Fixed
Error	The emergency alert to the doctor must include the patient's name	YES	Fixed
Error	Problem in the UI of the android app (YOGA 2 tablet)	NO	Fixed
Error	Online user on Android app	NO	Fixed
Error	Problems in the UI during the call	YES	Fixed
Error	Register new user through Tablet	NO	Fixed
Upgrade	Previous choices in "How do I feel today" appear along with other bio-signals.	NO	Fixed
Error	The email confirmation link for user registration does not work.	YES	Fixed
Error	Restore from background	NO	Fixed
Error	Spelling / Typographical Errors	NO	Fixed
Error	Medical history on mobile	YES	Fixed
Error	Normal values in history are wrong	NO	Fixed
Error	The weather shows the wrong location (Kalamaria)	YES	Fixed
Error	In the addition of a test, the control message does not specify what the problem is	NO	Fixed
Error	Selecting a Measurement Unit when Adding Testing Results	NO	Open
Error	Normal values in history are wrong	YES	Fixed

Error	Selecting a Measurement Unit when Adding Testing Results	NO	Open
Error	Wrong label name when adding a new reminder	NO	Fixed
Error	View photos	NO	Fixed
Error	Search for allergens	NO	Fixed
Error	Delete Reminder	NO	Fixed
Error	Unable to add exams from Att. Doctor	NO	Fixed
Error	Search for examination by typing	NO	Fixed
Error	problem in iOS call camera	YES	Fixed
Error	Add patient	YES	Fixed
Error	The accordion of examinations in the medical history is open from the beginning	NO	Fixed
Error	Incorrect reminder	NO	Fixed
Error	Back button off position	YES	Fixed
Error	AMKA length validation	NO	Fixed
Error	Search for mobile examinations	NO	Fixed
Upgrade	Notification button	NO	Fixed
Error	"How do I feel" automatic return	NO	Fixed
Error	The app crashes several times when it opens from notification	YES	Fixed
Upgrade	Delete Account from Helpdesk	NO	Fixed
Upgrade	Possibility to upgrade a user to premium	YES	Fixed
Upgrade	Registration Process	YES	Fixed
Error	Not Responded by iOS	YES	Fixed
Error	Notifications on iOS / Android	NO	Fixed
Error	Email for threshold overrun	NO	Fixed
Error	Message in Greek on login form	NO	Fixed
Error	Invitations accept link does not work	NO	Fixed
Error	The application crashes on different devices	YES	Fixed

Error	The examinations appear one by one	NO	Fixed
Error	Failed to call iOS	YES	Fixed
Error	Biosignals charts	NO	Fixed
Error	Functionality 'Notifications'	NO	Fixed
Error	Add a patient reminder	YES	Fixed
Error	The measurement download reminder remains active after taking a measurement	NO	Fixed
Upgrade	ESC button - View photos	NO	Fixed
Error	Manually add metrics	NO	Fixed
Error	moto g black screen in video	YES	Programmed
Upgrade	Reminders icon "	NO	Fixed
Error	moto g black screen in video	YES	Programmed
Upgrade	Add the tab "Add button" and the tab "Patients"	NO	Fixed
Error	Problem with doctor's mobile application	YES	Fixed
Upgrade	Changes the mobile UI	YES	Fixed
Error	Splash screen delay if no internet available	YES	Fixed
Error	Biomedical examination	YES	Fixed
Error	Acknowledge notification from pebble	YES	Fixed
Error	Single confirmation on logout	NO	Fixed
Error	Bigger icons	YES	Fixed
Upgrade	Notifications remain unread after logout / login	YES	Fixed
Upgrade	Mobile biosignals counts to have seconds	NO	Fixed
Upgrade	In the Light version, both the user name and the photo are displayed	YES	Fixed
Upgrade	Show Biosignals on Mobile	YES	Fixed
Error	reminder for heart rate measurement makes no sense	YES	Fixed
Upgrade	After logging in a new user login automatically	NO	Fixed

Error	Push notification does not go to the last device that logged in a user	YES	Fixed
Error	night screen operation	NO	Fixed
Error	Disable reminder for measurement	NO	Fixed
Error	Timeout Popup Exit / Change User	NO	Fixed
Error	Remote restart	YES	Fixed
Error	Call from reminder	NO	Fixed
Upgrade	In the Desktop / Helpdesk popup: ESC -> cancel, Enter -> OK	NO	Fixed
Error	Show a new contact invitation to all users	YES	Fixed
Upgrade	Doctor contact call (Mobile)	YES	Fixed
Error	Remote Restart and push notification fails In HOL network	YES	Fixed
Upgrade	Timeline for all users and helpdesk	NO	Open
Error	Text to speech	NO	Open
Error	Lag on screen	NO	Fixed
Upgrade	Method to turn off a pebble reminder	YES	Fixed
Error	Small Corrections on registration from mobile	NO	Fixed
Error	Measure Reminders	NO	Programmed
Error	Numbering in notifications	NO	Fixed
Upgrade	Timeline for all users and helpdesk	NO	Open
Error	Text to speech	NO	Open
Error	Measure Reminders	NO	Programmed
Error	Sometimes he sticks to the splash for a long time and does not login	NO	Fixed
Error	Today's weather is continually null	NO	Fixed
Error	The app crashes after a remote restart	YES	Fixed
Error	The application does not start automatically when the device lights up	YES	Fixed
Error	The application crashes when it opens after a new record	YES	Programmed

Error	In SensorsActivity be a fullscreen and the purple actionBar appear	YES	Fixed
Error	The application crashes when it opens after a new record	YES	Programmed
Error	Exception to Play	NO	Fixed
Error	Ringtone to the web	YES	Fixed
Error	Back Button on WebActivity does not close the application	YES	Fixed
Upgrade	English Support	YES	Fixed
Error	I can not define an automatic answer to a contact.	NO	Fixed
Error	Registration Redirect. It sticks to the picture below	NO	Fixed
Upgrade	When a contact call is shown in the contact list as inactive	YES	Fixed
Error	If a normal call closes the open listening session	NO	Programmed
Error	If a normal call closes the open listening session	NO	Programmed
Error	The invitation email does not open the application	NO	Fixed
Error	When connecting problems....	NO	Fixed
Error	Cancel the count reminder to return to the home page	NO	Fixed
Error	Call problems	NO	Programmed
Error	Weather - Reload location	NO	Fixed
Error	Promote an email invitation to iOS	NO	Fixed
Upgrade	Firefox support	NO	Fixed
Error	The measurement reminder has no title on the pebble	NO	Programmed
Error	Call problems	NO	Programmed
Error	Viewing biosignals on the mobile takes half the screen	YES	Fixed
Error	Delete the cache	NO	Fixed
Error	'How I Feel' does not appear as a graph on mobile	YES	Fixed
Error	Change profile image	NO	Fixed

2.4 Usability Guidelines

Considering the needs of future end users of the system and their limitations, the system was designed based on the following guidelines, utilizing the relevant literature, while also implementing some innovative ideas.

- **User interface:** The user interface of the mobile application was designed according to the established usability requirements for the elderly and people with sensory impairments. Large buttons, icons and fonts have been used to maximize readability. The colors used were chosen so as not to distract users from interacting with the system, taking into account the poor color and sensitivity of the older representatives. In addition to ensuring visual accessibility, colors were used appropriately according to their common interpretations (e.g., green is usually interpreted as positive).
- **Devices:** Users need to be able to interact with the system as naturally as possible, so device selection is vital. Different people express different preferences, which can greatly affect the level of comfort of a user with a system, with most usually choosing devices with which they are already familiar. The mobile app is able to adapt to the user's preferences, with a design response that can be run on a variety of devices, including smartphones and tablets, but also on TVs. Given that many seniors have difficulty using the keyboard or mouse, especially those with Parkinson's, the system focuses primarily on touch screens.
- **Multimodality:** The use of multiple ways to address the needs of people with sensory disorders is required, as the acidity of sensory ways decreases with age, especially in the case of chronic patients. For example, diabetes can lead to reduced vision, while the number of people with vision and hearing problems is increasing. This underscores the importance of touch-based notifications. For this reason, the system presents alerts and reminders with audio and visual alerts on the tablet, as well as vibration alerts on a smartwatch. Simultaneous use of multiple modes ensures maximum efficiency.
- **Understanding:** The majority of users unfamiliar with modern technologies perceive mobile applications as computer-based systems, which can cause them anxiety or fear. The user interface contains a few buttons to address this issue. For simplified navigation, menu inserts were avoided, ensuring that the application is understandable. In addition, important information is always presented with icons, not just text, to help users quickly understand what to do next.
- **Automation:** In order to minimize the level of power required by the end user, many tasks can be performed automatically (eg creating reminders, answering video calls automatically). In addition, tasks can be assigned to caregivers (eg creating a scheduling schedule, managing a

contact list). This ensures ease of use and reduces the possibility of fatigue or boredom when using the application. In addition, the application incorporates mechanisms for automatic connection to devices, which greatly simplifies data entry, as well as mechanisms for automatic recovery in case of failures, including automatic reconnection to the service and automatic restart of the application.

- **Motivation:** In order to motivate end users to interact with the system, enjoyable features such as photo sharing are an important addition. Sharing content between end users and their families is also important in promoting social interaction. In addition, the app's visualization capabilities allow users to see a daily graphic representation of their condition, providing an important communication tool between patients and doctors and a sense of empowerment to users.

The following are some indicative images from the end-user application, to which the above usability principles have a practical application.

The image below shows the initial interface with a patient's basic options through the Android application.



Figure 1: The initial interface that the patient sees after logging in to the Android application

The next screenshot shows the history sub-menu.

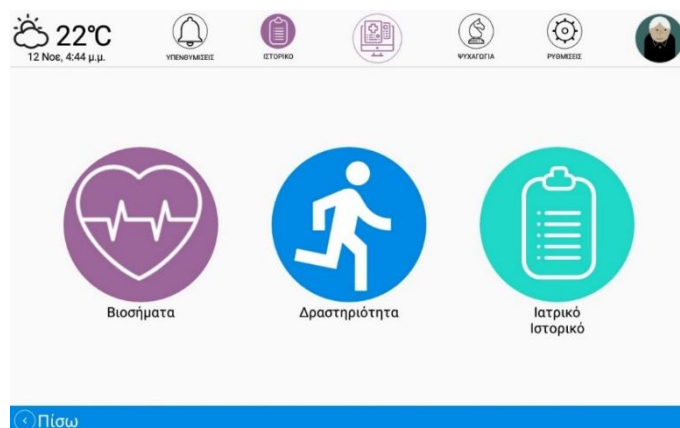


Figure 2: The options a patient sees when choosing to see his or her history.

3 Usability Evaluation

3.1 Usability Evaluation Methods

The purpose of a usability assessment is to determine how easily potential users of a system can learn to use it and assess their level of satisfaction with the process. Various methods have been proposed to evaluate the usability of the system, depending on the type of feedback required and the stage in the design and development of the system. Another aspect is who is involved in the process, with some methods based on feedback from potential users and others requiring the input of usability experts.

There are three basic approaches:

1. Inspection methods: This type of method involves observing users by a specialist. Popular methods of this type are ethnography, heuristic evaluation and pluralistic control. Users are usually not directly involved.
2. Research methods: In this approach, qualitative data is collected by system users. Examples of this category are focus groups, surveys and interviews.
3. Test methods: This approach refers to the collection of quantitative data from potential users in a realistic environment. Some examples are reference tests, remote usability tests, and the Think Aloud protocol.

To evaluate the mobile application of the Health Monitoring System, we used a test method, 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.

Some of the most widely used and reliable questionnaires for usability assessment are the System Usability Scale (SUS), the Website Analysis and Measurement Inventory (WAMMI) and the User Interaction Satisfaction Questionnaire (QUIS).

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 a cost-savvy method to implement, 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.

3.2 System Usability Scale

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.

	Διαφωνώ Απόλυτα	1	2	3	4	5	Συμφωνώ Απόλυτα
1. Νομίζω ότι θα ήθελα να χρησιμοποιώ το σύστημα συχνά.	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2. Βρήκα το σύστημα αδικαιολόγητα περίπλοκο.	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3. Σκέφτηκα ότι το σύστημα ήταν εύκολο στη χρήση.	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4. Νομίζω ότι θα χρειαστώ βοήθεια από κάποιον τεχνικό για να είμαι σε θέση να χρησιμοποιήσω το σύστημα.	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5. Βρήκα τις διάφορες λειτουργίες στο σύστημα καλά ολοκληρωμένες.	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6. Σκέφτηκα ότι υπήρχε μεγάλη ασυνέπεια στο σύστημα.	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7. Φαντάζομαι ότι οι περισσότεροι άνθρωποι θα μάθουν να χρησιμοποιούν το σύστημα πολύ γρήγορα.	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
8. Βρήκα το σύστημα πολύ περίπλοκο στη χρήση.	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9. Ένιωσα πολύ σίγουρος/η χρησιμοποιώντας το σύστημα.	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
10. Χρειάστηκε να μάθω πολλά πράγματα πριν μπορέσω να ξεκινήσω με το σύστημα.	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Figure 3 SUS Questionnaire

The SUS rating gives a score ranging from 0 to 100. This rating is calculated as follows:

- Calculate the individual score for each item.
 - For points 1, 3, 5, 7 and 9 the score is equal to the numerical value of the answer (1 to 5) minus 1.
 - For points 2, 4, 6, 8 and 10 the score is 5 minus the numerical value of the answer.
- Sum up the scores of all items.
- Multiply the sum by 2.5 to get the total SUS score.

Using the following graph, we can obtain the corresponding usability score for our score and a score between A and F. For example, for a SUS score of 74, the corresponding score is 70% and the score is B. Any system that has a score SUS greater than 74 is marked as "Good" and is considered acceptable in terms of usability.

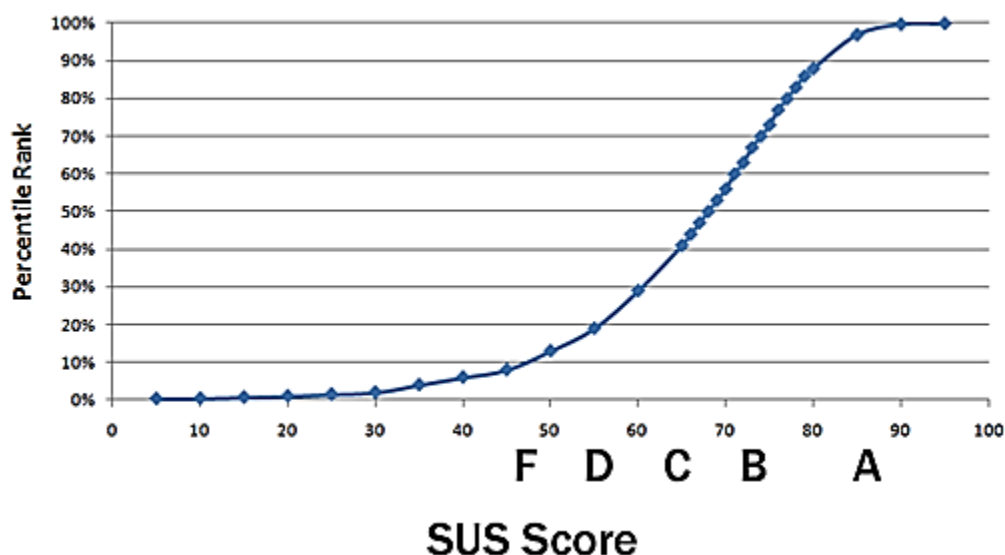


Figure 4 SUS % Scores

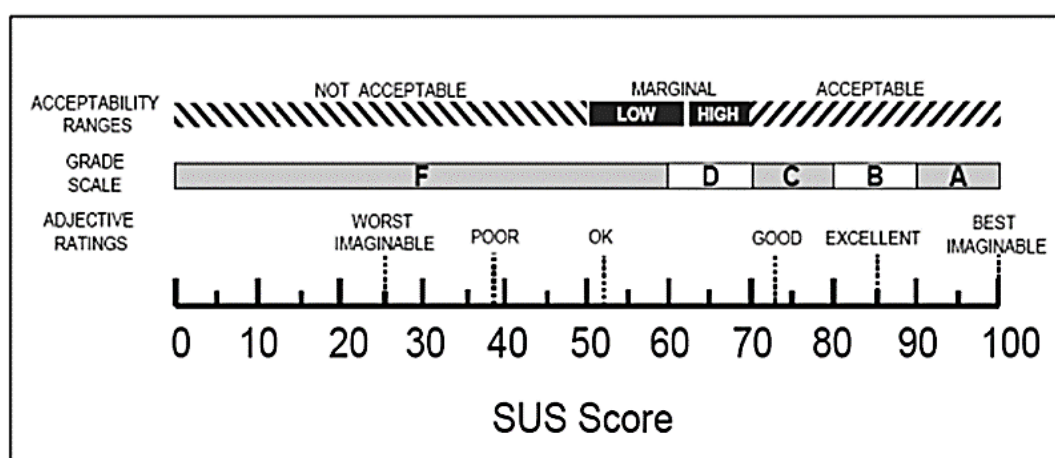


Figure 5 SUS Descriptive Scores

3.3 Evaluation Methodology

The study participants were potential end-users of the system. Excluded were people under 60 or with cognitive impairment. A random sample was taken, which included 20 participants, aged between 60 and 83 years, with equal representation of men and women. All participants had completed at least secondary education. The sample also included people with chronic conditions, such as cardiovascular problems.

The evaluation process began with the presentation of the system and its characteristics to the respondent. Prior to the assessment, respondents were given sufficient time (approximately 30 minutes) to use the system. Within this time frame, they were asked to perform a series of simple tasks with minimal assistance in order to explore the various possibilities of the platform. These tasks covered the most important use cases for each of the services provided by the system and included initiating video calls, receiving reminder notifications and performing the appropriate action, using a wireless sensor to record measurements, viewing photos and start an emergency call. Each participant then answered the SUS questionnaire.

4 Evaluation Results

The total score was 78.8, which was within the acceptable range, corresponding to grade C and the adjective "Good" score. The scores obtained from the evaluation ranged between 65 and 90 (average = 78, mean = 78.8) for the male respondents and between 70 and 92.5 (average = 79.5, mean = 77.5) for the women. As illustrated in the following graph, all respondents gave the system an acceptable score, which is indicative of the effectiveness of the usability principles applied.

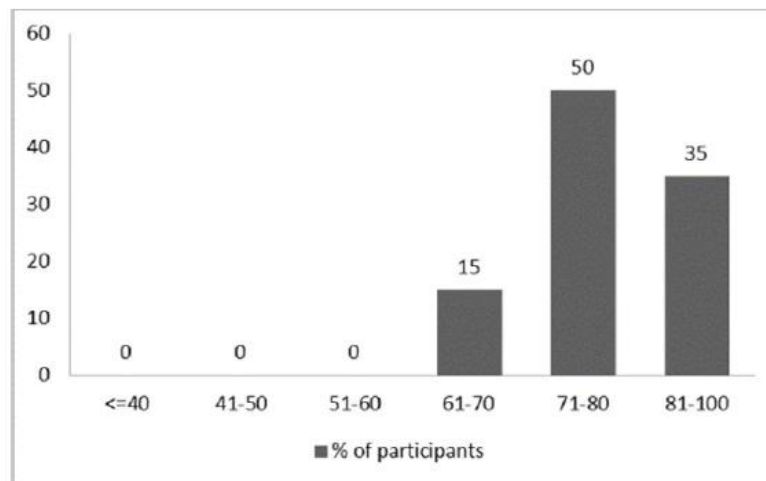


Figure 6 SUS Scores Distribution

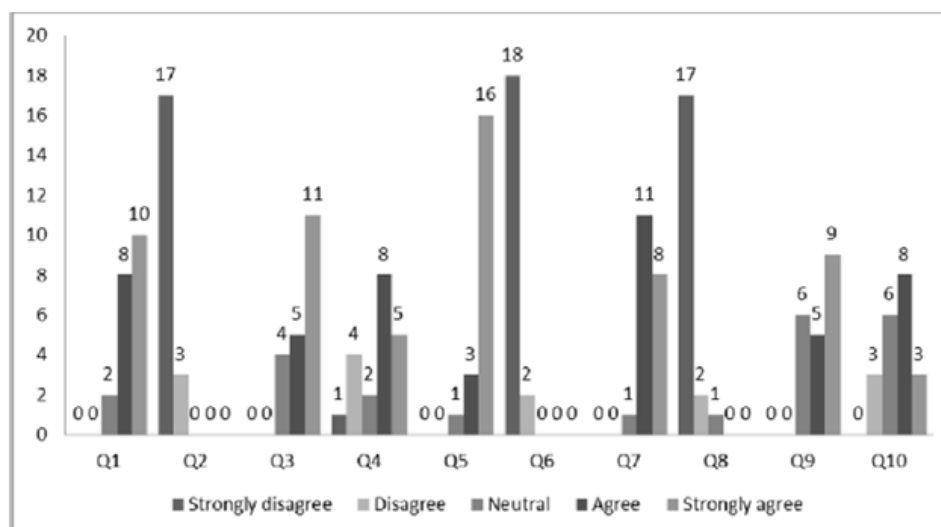


Figure 7 SUS Answer Frequencies

The highest scores, corresponding to grade A, were mostly given by participants who had some experience in tablet use. This shows that familiarity with the device is still a key factor. However, the lowest scores were not given by participants who had no computer experience, although most responded that they would need training and assistance in using the system. Thus, previous experience does not seem to be more important than other factors, such as participants' predisposition and confidence in learning. It is also worth noting that the scores did not always decrease as the age of the respondents increased.

The distribution of participants' answers is shown in Figure 10. Considering the answers to questions 1, 2, 3, 8 and 9, it is obvious that the principles applied in the user interface have successfully simplified the appearance of the application and boost users' confidence, and make them more willing to interact with the system and more confident when they do.

The answers to question 10 showed another positive effect of the principles applied, which was that most of the respondents felt that they could of course interact with the system without having to learn much in advance. Also, many of them agreed that most people would quickly learn to use the system. It should be noted, however, the attitude of the respondents towards question 4, which means that many of them believe that they will need support to use the system. This highlights the importance of remote management capabilities available to carers and the helpdesk.

5 Conclusions

This deliverable presented the usability assessment of the mobile application of the Integrated Health Monitoring System. The user interfaces have been designed according to some known usability requirements, taking into account the needs of older users. The SUS usability test gave us an overall evaluation of the system design, which validates the effectiveness of the applied design options.

In the future, ethnography could give us a much better understanding of how well potential end users could use the system in real life. Further evaluations and improvements should also include the perspective of the other users involved (eg doctors), as they can provide a more complete picture of the system's acceptance by its users.

6 References

- [1] Lee, B., Chen, Y., Hewitt, L.: Age Differences in Constraints Encountered by Seniors in their Use of Computers and the Internet. In: Computers in Human Behavior, vol. 27, no. 3, pp. 1231–1237 (2011)
- [2] Botsis, T., Demiris, G., Pedersen, S., Hartvigsen, G.: Home Telecare Technologies for the Elderly. In: Journal of Telemedicine and Telecare, vol. 14, no. 7, pp. 333–337 (2008)
- [3] Ojel-Jaramillo, J. M., Cañas, J. J.: Enhancing the Usability of Telecare Devices. In: Human Technology: An Interdisciplinary Journal on Humans in ICT Environments, vol. 2, pp. 103–118 (2006)
- [4] Renaud, K., Van Biljon, J.: Predicting Technology Acceptance and Adoption by the Elderly: A Qualitative Study. In: Proceedings of the 2008 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists on IT Research in Developing Countries: Riding the Wave of Technology, pp. 210–219 (2008)
- [5] Patsoule, E., Koutsabasis, P.: Redesigning Websites for Older Adults: A Case Study. In: Behaviour & Information Technology, vol. 33, no. 6, pp. 561–573 (2014)
- [6] Genise, P.: Usability Evaluation: Methods and Techniques: Version 2.0, University of Texas (2002)
- [7] Brooke, J.: SUS - A Quick and Dirty Usability Scale. http://cui.unige.ch/isi/icle-wiki/_media/ipm:test-suschart.pdf
- [8] Brooke, J.: SUS: A Retrospective. In: Journal of Usability Studies, vol. 8, no. 2, pp. 29–40 (2013)
- [9] Bangor, A., Kortum, P., Miller, J.: Determining What Individual SUS Scores Mean: Adding an Adjective Rating Scale. In: Journal of Usability Studies, vol. 4, no. 3, , pp. 114–123 (2009)
- [10] Stojmenova, E., Imperl, B., Žohar, T., Dinevski, D.: Adapted User-Centered Design: A Strategy for the Higher User Acceptance of Innovative e-Health Services. In: Future Internet, vol. 4, no. 3, pp. 776–787 (2012)