



NESTORE

D6.5 Integrated Tests Results



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769643

DELIVERABLE ID:	WP6/D6.5/TASK NUMBER 6.7
DELIVERABLE TITLE:	Integrated Tests Results
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NATURE	Report
DISSEMINATION LEVEL:	R, DEM
FILE:	Integrated Tests Results
REVISION:	V1
DUE DATE OF DELIVERABLE:	2020.01.31
ACTUAL SUBMISSION DATE:	2020.03.13
CALL	European Union's Horizon 2020 Grant agreement: No 769643
TOPIC	SC1-PM-15-2017 Personalized coaching for well-being and care of people as they age

Document History

REVISION	DATE	MODIFICATION	AUTHOR
0.1	2019.10.16	First version	Ciprian Candea, Marius Staicu, Gabriela Candea, Claudiu Zgripcea (ROPARDO)



0.2	2019.12.16	Review and update	Silvia Orte (EURECAT), Marta Civiello (FLEX), Eduardo Avallone de Souza (NEOS), Daniele Segato (NEOS), Filippo Palumbo, Paolo Baronti, Michele Girolami, Fabio Mavilia, Filippo Palumbo, Antonino Crivello (CNR-ISTI), Alfonso Simone Giovanna Rizzo, Simone Porcelli (CNR-ITB), Isabelle Kniestedt (TUD), Ciprian Candea, Marius Staicu, Gabriela Candea, Claudiu Zgripcea (ROPARDO)
2020.02.06	Marta Civiello	FLEX	Reviewer
2020.03.06	Laura Marone	POLIMI	Reviewer
2020.03.13	Paolo Perego	POLIMI	Reviewer
2020.09.04	Ciprian Candea & Gabriela Candea & Claudiu Zgripcea , Silvia Orte & Paula Subías-Beltrán & Stefan Dauwalder, Eduardo Avallone de Souza & Daniele Segato, Filippo Palumbo & Paolo Baronti & Michele Girolami & Fabio Mavilia & Filippo Palumbo & Antonino Crivello, Alfonso Simone & Giovanna Rizzo & Simone Porcelli, Isabelle Kniestedt , Mira El Kamali & Leonardo Angelini & Elena Mugellini	ROPARDO, EURECAT, NEOS, CNR-ISTI, CNR-ITB, TUD, HES-SO	Review and update



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Short Abstract

One of the NESTORE project's main goals is to create an ecosystem to give elderly people a coaching platform / system for guiding and optimizing their lifestyle. Thus, each component will be tested as a separate module, and then, in conjunction with other NESTORE components. Test cases are defined in this report in order to perform end-to-end integration tests.

The presented report will list some test cases for each component and the test protocol used by the NESTORE team to test the NESTORE system.

Key Words

Social Platform, Monitoring system, DSS, virtual coach, end-user, Nestore Connect, sensor



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1. Executive summary

The D6.5 report the work done in the testing activities. For a complete view of the test results please check the movies that are located on the NESTORE portal (Home -> Meetings -> 20191112 Remote Review -> Videos). The component tested are: Monitoring system (wearables, environmental sensors and social sensors), Virtual Coach (tangible interface, food recognition, cognitive status, sleep monitoring, serious games, social platform) and Decision Support System

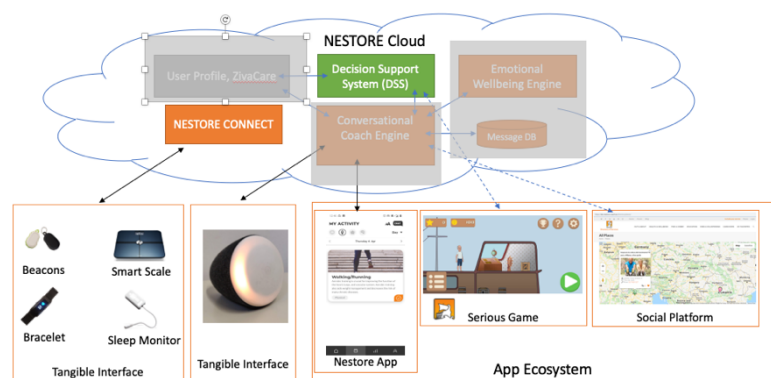
The NESTORE system can be tested using the link: <https://my.nestore-coach.eu/> and by installing on the smartphone the application. The access to the application is through login and password.



2. Relation with other work packages

The integration activities started based on the Description of Action in M19 until M26 of the project, then postponed to M29 with the extension requested and approved. The input necessary for this process is represented by the testing procedure for NESTORE components developed inside WP3, WP4, WP5 and WP6 (see Figure 1) :

- tangible coach,
- serious game,
- social platform,
- nutrition app,
- NESTORE (virtual coach) app,
- sleep and scale monitoring,
- DSS
- wearable & environmental sensors,
- NESTORE CONNECT



The output of this task is represented by the results of tests performed on NESTORE system as a whole and on each NESTORE component.



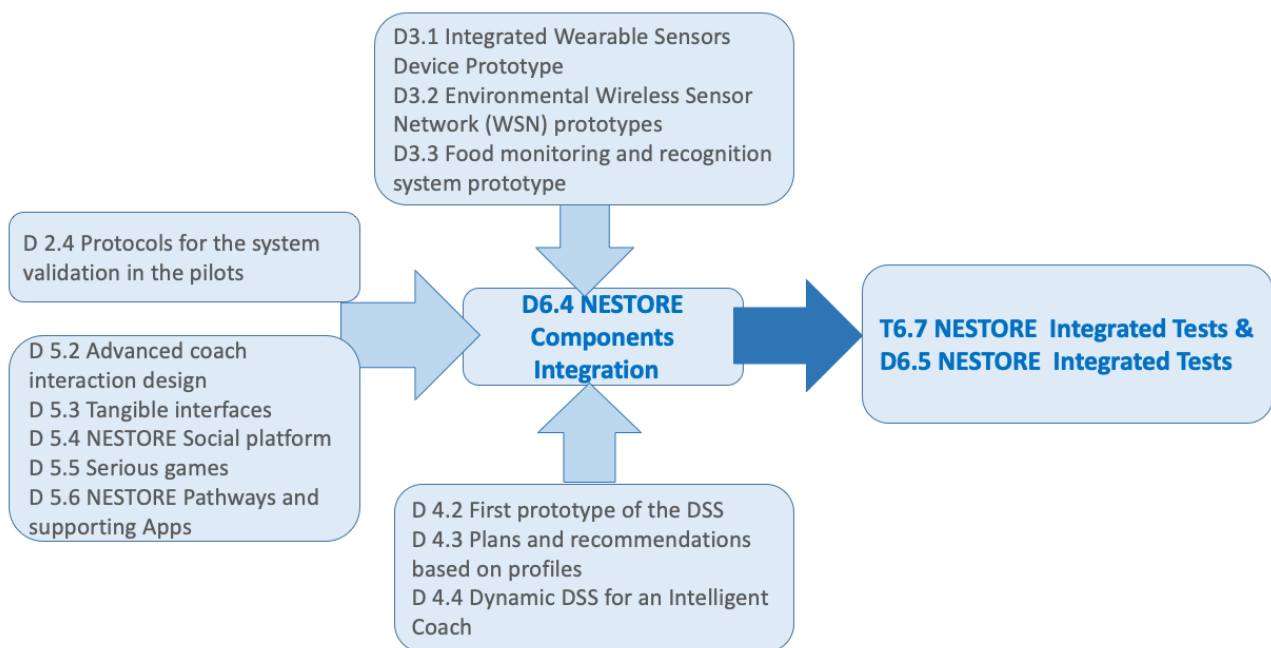


Figure 1 Graphical representation of the relationships between D 6.5 and other NESTORE tasks

This report is organised in chapters as follows: **chapter 3** contains the procedure for the testing activities of each NESTORE component; **chapter 4** details the testing procedure for **the NESTORE Monitoring System** (wearable & environmental sensors, NESTORE Connect); **chapter 5** describes the testing procedure for **NESTORE Virtual Coach** (NESTORE mobile app, Tangible Coach, Nutrition monitoring, Mobile APP Physical activity, Mobile APP Cognitive, Chatbot, Sleep activity and Social Platform); **chapter 6** outlines the testing activities for the Decision Support System (**DSS**); **chapter 7** describes the test cases for **Serious Game**.

The **chapter 8** details the procedure, tasks, end-users, problems and results of the **integrated tests** for NESTORE System. The results of integrated tests can be seen inside the videos (presented at the Remote Review Meeting from 12 of November 2019).



3. Template for testing the components

For each component developed inside NESTORE system, there was applied a series of tests in order to verify the compliance in regards to user requirements and pilot requirements. For each component the same structure is applied:

- a short description of user requirements
- description of component requirements and functionalities
- test cases for component tests

3.1. Pilot/user requirements

In this section are described the user and pilot requirements identified and analysed inside the WP2 and WP7.

3.2. Component requirements & functionalities

Within this section each component is described on short and presented the main functionalities.

3.3. Test-cases for component test

In this section there are described test cases for the functionalities mention above. Each test case follows the same structure, as described below.

3.3.1. Test-case x: Name of functionality

- a) Main flow
- b) Alternative flow
- c) Preconditions
- d) Post conditions

The components of NESTORE system

NESTORE system is a user-centered complex system composed by:

- Monitoring system (Scale, NESTORE Connect, wearables- bracelet, sleeping monitoring, social interaction beacons, environmental beacons)
- Virtual Coach (Social Platform, Tangible interface, e-coach app)



- Decision Support System (First two weeks phase, pathway selection, building DSS user profile, recommendation of structured activities, recommendation of unstructured activities)
- Serious Game



4. Testing the NESTORE Monitoring System

The NESTORE Monitoring System contains:

- Wristbands
- Wristband charging stations
- Beacons (social and environmental)
- Smart scales (commercial)
- Sleep monitoring systems (purchased)
- NESTORE Connect - Android BLE library data exchange

More details about the tests performed can be found in deliverable D.3.1 Integrated Wearable Sensors Device Prototype, Annex 1 Wearable device Tests and Annex 2 Software/Firmware Ad-hoc tests report.

Because the Sleep monitoring sensor and Smart Scale are purchased, there wasn't performed individual tests for these, but there were prepared only the installation manuals,

- the installation instruction for Sleep monitoring sensor can be found in Annex 3;
- the installation instruction for Smart Scale can be found in Annex 4;

4.1. Environmental & Social interaction sensors

The testing procedure for the environmental /social beacons and the wristband consists in checking that the wristband can successfully collect beacons and upload them to the NESTORE Cloud. To this purpose, we assume that the tester has:

- Configured 5 environmental beacons;
- Configured 5 social beacons;
- Configured the Nestore Connect Agent and and he/she has performed the setup of the Nestore wristband.

Procedure:



1. Install the NESTORE Connect on your smartphone.

- Log in with the NESTORE user account;
- Perform the initial Setup of the Wristband with Nestore Connect: configure the wristband with user data, current time and beacons identifiers;



2. The tester wears the wristband

3. The Tester places the set of 10 beacons on a desk

4. The tester stands close to the beacons 1-meter distance for 4 minutes. The goal is to collect beacons

- Record on a paper: start timestamp in ISO format ex: 2019-08-01T11:30
- Record on a paper: end timestamp in ISO format ex: 2019-08-01T11:34

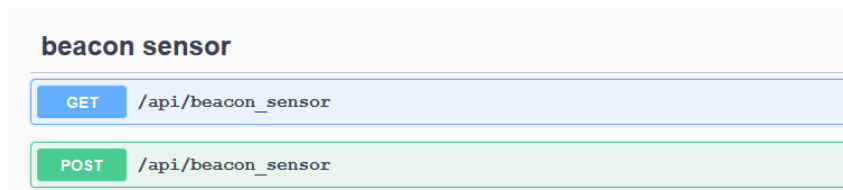
5. Wait for the NESTORE connect to synchronizes with the wristband and the cloud, this is completely automatic. For a semi-manual procedure follow these steps:

- Wait the next hour (if it's currently 11:34, wait for 12:01)
- Go into the Wearable section of the Nestore Connect, disable the auto-synchronization, wait 3 seconds, enable it again, this will force a synchronization of the pending tasks
- Enable Developer Mode in the homepage of the Nestore Connect (bottom of the screen)
- Enter Monitor Section of the Nestore connect (only visible while Developer Mode is ON)
- Check in "Recent Tab" for the synchronizations tasks on beacons (social / environmental), non-structured activities and sedentariness.

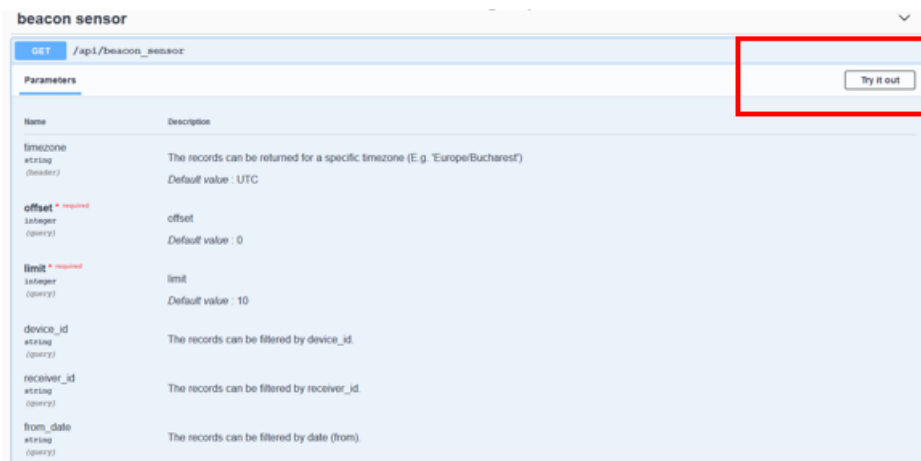
6. Double check that the data uploaded at step #4 are available:

- From the web, open the URL: <https://datastore.robofuse.com/>
- Find "beacon sensor" section





- Click on the GET /api/beacon_sensor
- Click in “TRY IT OUT” button on the top right corner



- Fill the form with the following information



beacon sensor

GET /api/beacon_sensor

Parameters

Name	Description
timezone string (header)	The records can be returned for a specific timezone (E.g. 'Europe/Bucharest')
offset integer (query)	offset
limit integer (query)	limit
device_id string (query)	The records can be filtered by device_id.
receiver_id string (query)	The records can be filtered by receiver_id.
from_date string (query)	The records can be filtered by date (from).
to_date string (query)	The records can be filtered by date (to).

- device_id = paste the ID of the wristband used. Example: C4:64:E3:F0:B6:95
- from_date: starting timestamp of the test converted to UTC. Example: 2019-08-01T11:30 -> 2019-08-01T10:30 if local time is UTC+1
- to_date: ending timestamp of the test converted to UTC. Example: 2019-08-01T11:34 -> 2019-08-01T10:34 if local time is UTC+1
- Press "EXECUTE" button
- Double check that the Response Body section shows some data collected. As for example:
- Scroll the list of the beacons received and for every environmental/social beacon previously configured make sure that you can find at least 1 entry with such beacon. For example, if the tester configured the 5 social beacons as follows:
 - Social beacon 1 with ID= A4:64:E3:F0:B6:95
 - Social beacon 2 with ID= B4:94:E3:F0:B6:88

Response body

```
{
  "beacon_sensor": [
    {
      "deviceid": "FD:2D:11:C6:35:4E",
      "receiverid": "C4:64:E3:F0:B6:95",
      "timestamp": "2019-08-12T07:53:58+00:00",
      "temperature": null,
      "humidity": null,
      "accelerometer": null,
      "battery": 99,
      "rssi": -61,
      "timestamp_raw": "2019-08-12T09:53:58+02:00"
    },
    {
      "deviceid": "D2:B8:0D:81:2B:79",
      "receiverid": "C4:64:E3:F0:B6:95",
      "timestamp": "2019-08-12T07:53:58+00:00",
      "temperature": null,
      "humidity": null,
      "accelerometer": null,
      "battery": 100,
      "rssi": -65,
      "timestamp_raw": "2019-08-12T09:53:58+02:00"
    },
    {
      "deviceid": "E8:24:F1:22:76:0E",
      "receiverid": "C4:64:E3:F0:B6:95",
      "timestamp": "2019-08-12T07:53:58+00:00",

```



- Social beacon 3 with ID= C2:94:E3:F0:B8:11
- Social beacon 4 with ID= D2:94:E3:F0:B8:12
- Social beacon 5 with ID= E2:94:E3:F0:B8:07
- For each of the environmental/social beacons (1 to 5) you have to find at least one entry where field “receiver_id” matches the ID of the social beacon.

Repeat the check for every environmental and social beacon

4.2. NESTORE CONNECT

The main goal of Nestore Connect is to be the link between the wearable and the cloud services. With Nestore Connect the user can setup the wearable and periodically retrieve data(e.g., Beacon Environmental, Beacon Social, Sedentariness or Activities).

Nestore Connect also allows the user to setup the Tangible by connecting and passing the wifi information need by the tangible and the user token to access the cloud services.

The coach app can enable activities on the wearable via Nestore Connect, these activities are uploaded to the cloud sometime after the end of the activity by Nestore Connect.

4.2.1. Requirements Pilot/user requirements for NESTORE Connect

The NESTORE Connect is needed to allows the user to communicate with the Wearable and the Tangible. It allows the user to:

- Setup Wearable and Tangible;
- Enable activities/tests requested by NESTORE Coach app;
- Retrieve data generated by the wearable;

Nestore Connect was designed for minimum interaction from the user side, once the setup is performed, the app will operate in background. The user will be required to interact with the app after that only if a synchronization issue happens or if the wearable is not communicating with the app.



4.2.2. NESTORE Connect requirements & functionalities

The app Nestore Connect is available at Google Play Store (<https://play.google.com/store/apps/details?id=com.neosperience.nestoreagent>) and to be able to download it the user needs to be added to a whitelist. The user also needs to be already registered and to have already fulfilled the profile with the basic information on the NESTORE system before trying to use the NESTORE Connect.

The min Android version needed to use the app is Android 5.0 (SDK 21).

To perform the Login and retrieve user profile the user will need to be connected to the Internet.

To perform the setup of the wearable the user profile must contain at least the following information: age, gender, height, weight and the wearable MAC ADDRESS.

The NESTORE Connect perform these tasks:

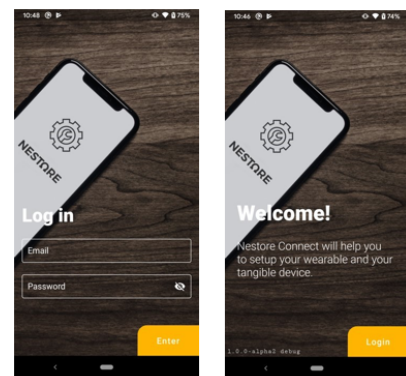
- Login
- Setup Wearable
- Setup Tangible
- Setup the wearable to perform a structured activity (can be performed from the Nestore Connect but usually is triggered from the Nestore Coach App)
- Setup the wearable to perform a physical test (can be performed from the Nestore Connect but usually is triggered from the Nestore Coach App)
- (no user intervention) Automatically (and periodically) synchronize data from the wearable to the Nestore Cloud
- (no user intervention) Automatically (and periodically) update the wearable data of the user related to physical domain (ex. weight)
- Periodically check for issues with the system setup and propose the user a Recovery Procedure (ex. the wearable needs to be reconfigured because it has been shut down, too much time without receiving data etc..)
- Debug data synchronization through Developer Mode and Monitor Section (Advanced task only meant to be used by pilot managers)



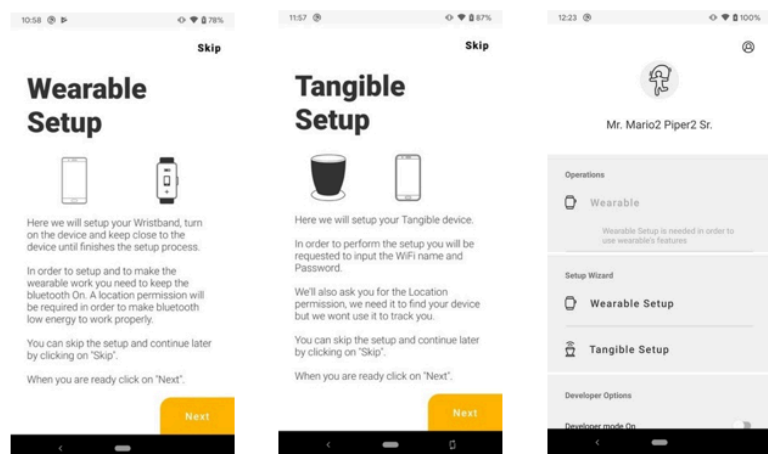
4.2.3. Test-case 1: Login in the app

Main flow

1. Download the app NESTORE Connect from Google Play Store;
2. Open the app NESTORE Connect on the smartphone;
3. On the Welcome Screen click **“Login”** to proceed to the login screen
4. Insert the email registered on NESTORE Portal and Password and press **“Enter”**



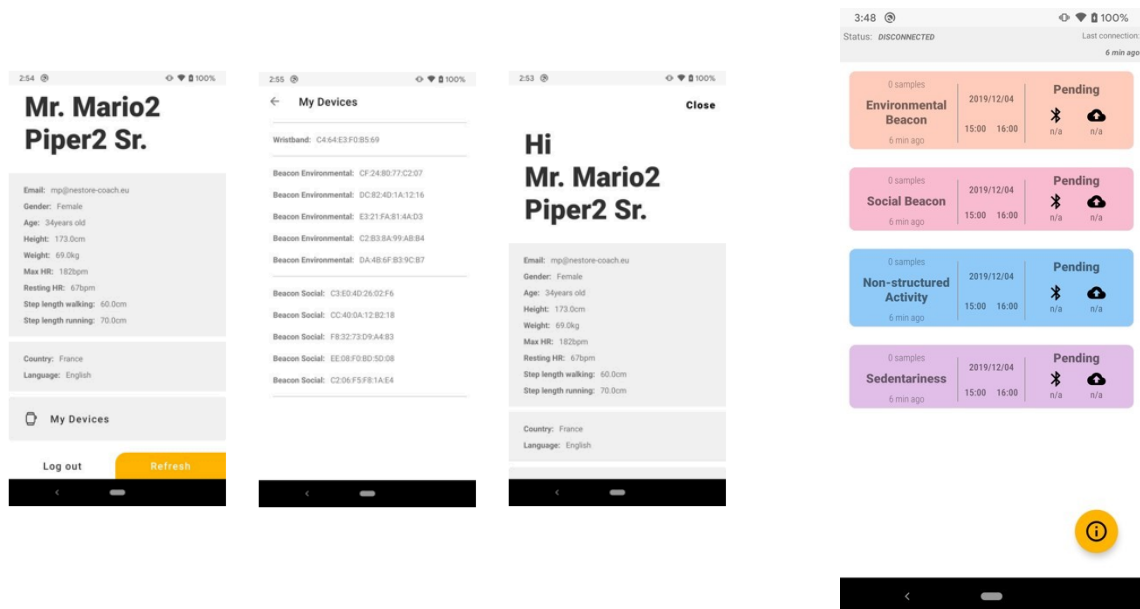
5. Right after the Login the user is invited to setup the Wearable. It's possible to skip and perform the setup later.
6. Right after the Wearable Setup, the user is invited to setup the NESTORE Tangible device. It's possible to skip and perform the setup later.
7. The User has arrived at the Home Screen.



4.2.4. Test-case 4: Check User profile and Devices MAC ADDRESS

Main Flow:

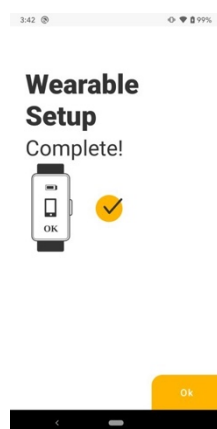
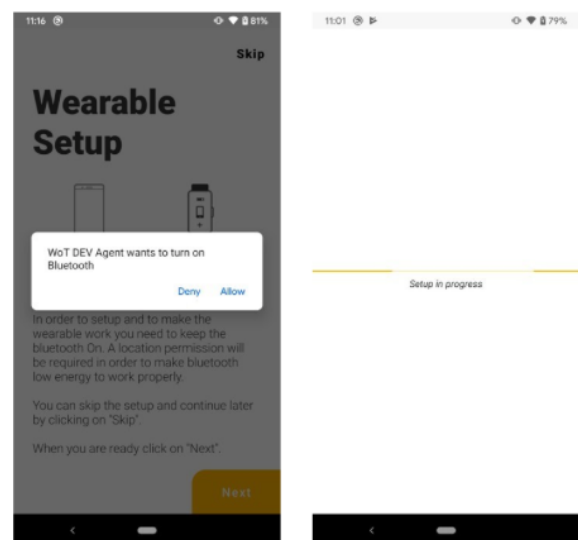
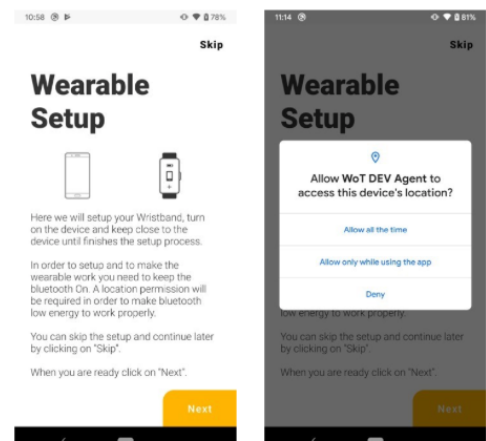
1. From the Home Screen the user can click on the profile icon on the top right corner which will bring to the Profile Screen. Here the user can check if all data has been loaded correctly;
2. On this screen, it's available a button **"My Devices"** that will bring the user to a My Devices screen with all devices MAC ADDRESS.
3. Any change performed on the web on the profile is not updated automatically on the device. The user can use the **"Refresh"** button to reload all the data from the profile.
4. user can use the **"Refresh"** button to reload all the data from the profile.



4.2.5. Test-case 2: Setup Wearable

Main flow

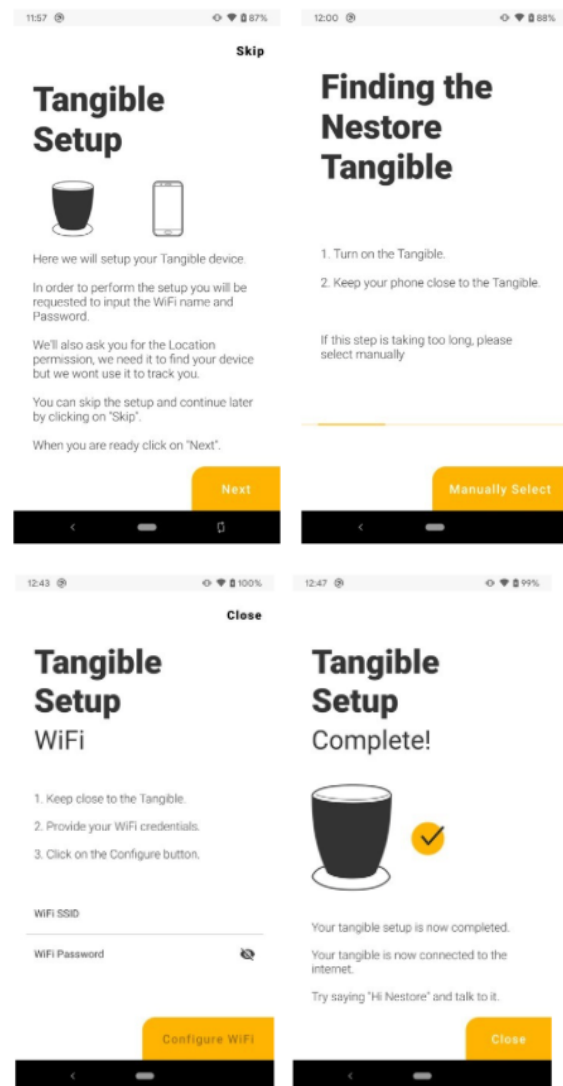
1. From the HomeScreen of the app the user can tap “Wearable Setup” to start the setup of the NESTORE Wearable device.
2. Turn on the wearable and leave it near the smartphone before pressing “Next”.
3. The Location permission will be requested since for the usage of Bluetooth low energy it’s needed. To work properly in background the app needs the permission “Allow all the time”. If the user has already given the permission, this step will be skipped.
4. The user will be requested to turn on the Bluetooth in case it’s off. To be able to connect to the wearable the app needs to keep the Bluetooth on. If the Bluetooth is already on, this step will be skipped;
5. The setup will proceed automatically and a Success screen will be displayed.



4.2.6. Test-case 3: Setup NESTORE Tangible

Main flow:

1. From the HomeScreen of the app the user can tap “Tangible Setup” to start the setup of the NESTORE Tangible device.
2. Turn on the Tangible device and leave it near the smartphone before pressing “Next”.
3. The location permission will be requested since for the usage of Bluetooth low energy it’s needed. To work properly in background the app needs the permission “Allow all the time” If the user already gave the permission, this step will be skipped.
4. The user will be requested to turn on the Bluetooth in case it’s off.
5. The app will try to identify the Tangible automatically but if this doesn’t work, the user can click “Manually Select” and choose the one that represents the Tangible from the Bluetooth list of devices.
6. Once the device is identified it’s time to select which Wi-Fi network the tangible will be connected to. From “Wifi SSID” select the network that will be used. On “Wifi Password” add the password to use that Wi-Fi. Once both fields are fulfilled click “Configure Wi-Fi” to proceed. The Wi-Fi network information and the user identification will be setup on the Tangible device.
7. A Setup complete message will be displayed and “Close” button to finish the setup.



4.2.7. Test-case 5: Monitor sync tasks (Developer Mode Only)

Main flow:

1. From the Home-Screen the user (only if developer mode is enabled) will see a “**Monitor Tasks**” button.
2. Inside the Monitor Task screen, it’s possible to see each part that needs to sync or that is already synced. Each part represents one of the types of data with a slot of one hour for that type. The full sync includes sync from the wearable, store locally before sending it to the cloud and upload to the cloud. After this the task is marked as “**Done**”;
3. On Top it is also possible to see the time from last connection and the current status of the connection with the wearable.
4. The floating button “I” brings the information about the synchronization like the last generated and last scheduled to be performed for each type.



5. NESTORE Virtual Coach

The Virtual coach is composed of:

- NESTORE mobile app,
- Tangible Coach,
- Nutrition monitoring,
- Mobile app Physical activity,
- Mobile app Cognitive,
- Chatbot,
- Sleep activity and
- Social Platform.

5.1. Tangible Coach

The main goal of the tangible interface, or also named: the tangible coach, is the ability of the user to have another form of companionship, friend and coach. In particular, the ability of the user to “touch”, “hear” and “speak with his voice” is another way of making the user to build a relationship with the NESTORE coach. The tangible gives information to the user every morning about the scheduled and recommended activities for the day and the score of all domains depending on the user’s pathway. The tangible coach sends a notification to the user 3 days per week to ask him about his/her feelings for the day. Once the coach detects the feeling of the user, it will let the user know about his/her detection. At weekly basis, the tangible coach will tell the user about his highest feelings the user has felt during the week.

The tangible coach interacts with the NESTORE connect to configure its internet connection and to let the user login with his/her account to the coach (mobile app). The tangible coach interacts with the “node engine server” in the NESTORE cloud that directly interacts with the decision support system and the user profile and zivacare and the emotional modal server.

More details about the tangible coach are in the deliverable D5.3 Tangible Interface.



5.1.1. Requirements Pilot/user requirements for Tangible Coach

Highly customizable (Personalized)

The tangible coach needed to allow the users to:

- Login with the user's NESTORE account via the Nestore connect in order to get a personalized experience.
- Open Bluetooth on his mobile phone
- Connect his NESTORE connect to NESTORE-tangible
- The user should send the Wi-Fi credentials to let the tangible coach have internet connection.

The users strongly expressed the need for vocal interaction.

Privacy and sharing settings should be as clear and customizable as possible and the default configuration should avoid to share any information with anyone. The system should also be very clear when these configurations are about to change.

5.1.2. Tangible Coach requirements & functionalities

The design of tangible coach was a result of a co-design with elderly people and with different designs.

Only NESTORE accounts users can have a conversation with the tangible coach. If the user did not login in Nestore connect and sends his credentials to the tangible coach, thus the coach will always tell the user to login with his account.



Figure 2 Tangible Coach - sleep state

If the tangible coach does not have internet connection then the coach will always tell him to connect the coach to WIFI



The coach has a “sleep state” and a “wake state”. The sleep state makes the coach reset himself, check if a language needed to be changed, and the coach will not be able to listen to the user anymore or speak. The tangible coach is actually sleeping. The wake state makes the coach wait for the “nestore” wakeword, and via different patterns of LEDs design, the user will be able to interact with the coach which will be 1) “hearing”, “thinking”, “speaking”

If the user did not precisely specify the language he/she wants in his/her mobile app or social platform, then the default language will be in English. The user can always change the language of the tangible coach, by changing the language in his/her nestore mobile app or social platform. The user should re-put the coach in the “sleep state” to make the coach change the new language.



Figure 3 Tangible Coach - Wake state

The user will have the onboarding conversation with the tangible coach to understand the role of the coach.



Figure 4 Tangible coach listening state

The user can ask about his/her scheduled and recommended activities for the day.

The user can receive his/her calculated score over a week in the different domains of NESTORE depending on their pathways.

The user can have a question-answer discussion.



The user will receive a notification from the tangible coach in a rainbow form of colors and will have the opportunity to tell the coach about his/her feelings. The coach will analyse the user's sentence and let the user know about the emotion detected.

The user should better keep the coach on sleep state and charging while not using.

5.1.3. Test-case: Conversation between user and tangible

Main flow

Conversation between user and tangible (started by the user)

- Put the coach in the wake state;
- Wakes the coach by saying NESTORE;
- Once tangible show orange light, ask a question to the coach;
- Waits for the coach to think about the answer related to his question(the coach shows turning orange lights);
- The coach give the response to the user (light blinks orange).

Alternative flow

Conversation between user and tangible (started by the tangible coach):

- Puts the coach in wake state;
- Wakes the coach by csaying NESTORE;
- Coach starts thinking of his question and then asks the user a question "how are you feeling today?";
- User responds when seeing orange lights;
- Coach detects user's feelings and answers the user (blinking orange).

Preconditions (login and setup):

User should login the NESTORE connect mobile application and perform the Tangible Coach setup in order to send the WiFi credentials and his user account and language.



5.2. NESTORE Mobile app

The main goal of the mobile application is to provide coaching to the user and support for scheduled activities via visual interaction. It also supports reflection on the data collected by the platform. The user will be able to schedule his/her activities, monitor his/her nutrients intake by sending photos of dishes, solve cognitive exercises, check his/her score of each domain and pathway, check the data collected through the different sensors and questionnaires. Therefore, the mobile app is both a coaching interface and a self-monitoring interface.

The mobile app content is provided by a Node.js server in the nestore cloud, which is directly connected to the user profile, Zivacare APIs and the DSS. It also communicates with broadcast messages with the NESTORE Connect app, for setting up structured activities and tests in the smart bracelet (see Annex 1).

5.2.1. Requirements Pilot/user requirements for mobile app

Customization was a requirement for the most part of the NESTORE system. Privacy and sharing settings should be as clear and customizable as possible and the default configuration should avoid to share any information with anyone. The system should also be very clear when these configurations are about to change.

5.2.2. Test-case: APP navigation tangible

Main flow

- The user access the app through the icon in the phone
- The user is automatically logged in and prompted to the home welcome screen
- The user can access the calendar tapping on the second icon in the bottom menu
- A calendar view is shown with the current day (or the last view setting). The user can change the view selecting the week, the month, and scrolling them with arrows, as well as the domain.
- The user can access the charts in tapping the fourth icon in the bottom menu with the current day (or the last view setting). The user can change the view selecting the week, the month, and scrolling them with arrows, as well as the domain.



- The user can access the profile and app settings tapping on the fifth icon in the bottom menu.
- The user can register or start new activities in the different domains tapping in the central “+” button.

Prerequisite

- NESTORE Coach app installed from Play Store
- User registered in the NESTORE web portal
- User is logged in in the app
- Baseline assessment completed

5.3. Mobile APP Physical activity

5.3.1. Test Case – Set up of a physical activity test

Main flow

- “New activities” tab in the home show a number >0
- The user tap in the orange tab “New Activities”
- In the new activity tab there is a *30 second chair raise* or *6 minute walking* test
- Tap on the “Details” text in the card. Details are shown
- The user tap in the stat icon
- The user is prompted to a new screen where he can start the activity
- The user tap on the “start” button, the Coach app sends the message to the NESTORE Connect app, which starts the bracelet set up. A loading interface is shown while waiting for the NESTORE Connect app.
- The bracelet is set up and the test icon is shown.
- Press the button and perform the test. At the end of the test, in the app, push the button “I’m finished”.



- The test activity is not present anymore in the New Activity tab

Prerequisites:

- NESTORE Coach app installed from Play Store
- User is registered in the NESTORE web portal
- User is logged in in the app
- Baseline assessment completed
- NESTORE Connect installed
- NESTORE bracelet is set up and worn by the user
- A test activity has been sent by the DSS to the coach app.

5.3.2. Test Case – Set up of an aerobic fitness structured activity

Main flow:

- “New activities” tab in the home show a number >0
- The user tap in the orange tab “New Activities”
- In the new activity tab there is a new cardiorespiratory fitness activity
- Tap on the “Details” text in the card. Details are shown
- Tap in the clock icon
- The user is prompted to a new screen where he can set the day and the time of the activity
- The user confirms the selection and is prompted to the new activity tab. The scheduled activity is not present anymore in the new activity tab
- The user closes the new activity tab and opens the calendar
- The scheduled activity is shown in the pathway tab as well in the physical activity tab for the current day, week and month



- The user receives a reminder for doing an activity 15 minutes before it starts. The user can click on the start button.
- The user is prompted to a new screen where he can start the activity. The description is shown.
- The user tap on the “start” button, the Coach app sends the message to the NESTORE Connect app, which starts the bracelet set up. A loading interface is shown while waiting for the NESTORE Connect app.
- The bracelet is set up and the running icon is shown.
- The user presses the button in the bracelet and performs the activity. At the end of the activity, in the app, pushes the button “I’m finished”.
- The user is prompted for the Borg questionnaire in the chatbot. The user is prompted for the review of the activity
- After 3 hours (worst case of time needed for the NESTORE Connect to sync the data activity in the cloud), the user can check the results in the chart, day view current day, physical activity domain.

Prerequisites:

- NESTORE Coach app installed from Play Store
- User registered in the NESTORE web portal
- User is logged in in the app
- Baseline assessment completed
- 2-weeks monitoring completed
- User has selected the pathway “Improve or retain Aerobic fitness”
- NESTORE Connect installed
- NESTORE bracelet is set up and worn by the user
- DSS sent a new coaching activity plan including a structured activity for training the memory



5.4. Nutrition monitoring

5.4.1. Pilot/user requirements

- Core themes emerging from co-design
- Health related data is accurate and can be viewed in real time by users of the system
- The system will translate health data into contextualised user centred feedback appropriate to its audience
- The system should be robust and withstand everyday use
- Responsiveness of the system to reflect the needs and preferences of the end user (personalisation) (e.g. access to content across the four domains).
- Consideration of ergonomics
- Interface should be clear, concise and elegant with the opportunities for manual customisation by the user reflecting their own preferences and style
- The visual interface (e.g. icons) should be easily recognisable, provide consistent look and feel
- Single sign in (log in once rather than multiple times)
- When the user changes the interface settings the interface should be updated immediately and continuously

5.4.2. Test-case 1: Input of new Food Log

Main flow:

1. Click “+” button at the bottom menu bar.
2. Click “Basket” icon.
3. The user presses the button camera to take a picture.
4. The user sees the image of the camera and focuses on the food.
5. The user takes a picture and confirms it.
6. NESTORE app is giving a list of the possible foods appears on the screen.



7. The user chooses a dish/food item from the list and clicks “Add”.
8. The nutritional information for the dish appears. He/she is asked to choose the quantity of the food (small, medium or large).
9. The user clicks “Save” and an informative screen appears informing that the dish was registered as well as a nutritional advice.
10. The user clicks the “X” button to go back to the main menu.

Alternative flow:

- | | |
|---------------|---|
| Alternative 1 | The user clicks the gallery button and chooses a picture of food from there. |
| Alternative 2 | The user corrects the food type from the available options (dish, drink, combo, and ingredient).
The user chooses a dish/food item from the list and clicks “Add”. |
| Alternative 3 | The dish/food item does not appear in the list. The user selects the option “Manual Search”.
The user selects a food type from the list.
The user uses the text search to write the name of the dish/food item. |

Preconditions

1. The phone has an internet connection.
2. The phone needs to have a working camera.

Post conditions

If the user goes to the “Calendar” menu, he should see the recently logged food (see Test-case 2).

5.4.3. Test-case 2: Visualize list of previously logged food intake

Main flow

1. Click “Calendar” icon at the bottom menu bar.
2. Click “Basket” icon at the top menu bar (under the title “MY ACTIVITY”).
3. The user can visualize by default all the food images and dish names logged on the current date.



4. The user can change the time range displayed selecting either “Day”, “Week” or “Month”. Thus, the corresponding logged food images appear.

Alternative flow

Alternative The user uses the left “<” and right “>” arrows to navigate along time.

Preconditions

1. The user has already logged some pictures.

Post conditions.

None.

5.4.4. Test-case 3: Input water intake

Main flow

5. Click “+” button at the bottom menu bar.
6. Click “Glass” icon.
7. In the appearing menu, tap as many glasses as the user drank along the day.
8. Click “Save”.

Alternative flow

None

Preconditions

None

Post conditions.

The total quantity of water should appear in the summary charts.

5.5. Mobile APP Cognitive

5.5.1. Test case – Baseline

Main Flow:



- User taps on the numerical updating task (first task to be completed at baseline). Instructions are shown.
- A tutorial is shown. 2 cells are shown, then 2 operations per cell are shown.
- The user enter a number per each cell, based on the operations shown. The result of the answers is shown. The app says how many correct numbers the user found.
- The app asks the user if s/he understood the task
- The user answers yes, then a new level is shown. A tutorial is shown at the beginning of a new level. The user completes the tutorial for the task, at the end, the apps ask the user if she's ready to register the task. If yes, a message "the task will be registered" will be shown at the beginning of the task.
- At the enf of a task that is registered, the counter for the task is incremented. 6 different levels are proposed to the user, 2-cell, 3-cell, 4-cell, both can be fast or slow. Each level is repeated twice. The order of levels is randomized.
- At the end of the numerical updating task, the counter shows 12/12 and a orange tick.
- User taps on the n-back task (second task to be completed at baseline). Instructions are shown
- A tutorial is shown. The user has to say if the number in the cell appeared 2 times ago, answering with yes or no buttons. A pseudorandomized sequence of numbers is shown.
- The app asks the user if s/he understood the task
- The user answers yes, then a new level is shown. A tutorial is shown at the beginning of a new level. The user completes the tutorial for the task, at the end, the apps ask the user if she's ready to register the task. If yes, a message "the task will be registered" will be shown at the beginning of the task.
- At each correct answer, the counter top left is incremented. The final score is shown to the user.
- At the enf of a task that is registered, the counter for the task is incremented. 2 different levels are proposed to the user, 2-back and 3-back. Each level is repeated three times.
- At the end of the n-back, the counter shows 6/6 and a orange tick.
- The user answer the three remaining questionnaires (25 questions on cognitive failures, 6 questions on loneliness, 6 questions on social integration). At the beginning of each questionnaire, instructions are shown. For each question, buttons or checkbox lists are shown.
- At the end of each questionnaire the counter is updated to 1/1 and a orange tick.
- At the end of all the task a new button for starting the 2-weeks monitoring appears.



Prerequisite:

- NESTORE Coach app installed from Play Store
- User registered in the NESTORE web portal
- User is logged in in the app

5.5.2. Test case – Numerical Updating Task trainingMain Flow:

- “New activities” tab in the home show a number >0
- The user tap in the orange tab “New Activities”
- In the new activity tab there is a new memory training activity
- The user tap on the “Details” text in the card. Details are shown
- The user tap in the clock icon
- The user is prompted to a new screen where he can set the day and the time of the activity
- The user confirms the selection and is prompted to the new activity tab. The scheduled activity is not present anymore in the new activity tab
- The user closes the new activity tab and opens the calendar
- The scheduled activity is shown in the pathway tab as well in the cognitive tab for the current day, week and month
- The user receives a reminder for doing an activity 15 minutes before it starts. The user can click on start.
- The user is prompted to the Numerical updating task. Or he can manually start the task from the “+” button, cognitive icon.
- The number of cell of the task depends on the accuracy of the previous tasks. If >75%, the next level is proposed. If <25% the previous level is proposed. The levels are 2-cells, 3-cells, 4-cells. All of them are in the slow version.
- The user is free to train several times. The app recommends to train for 15 minutes.
- After the training session the user can check the score in the charts, in the cognitive section.



Prerequisite:

- NESTORE Coach app installed from Play Store
- User registered in the NESTORE web portal
- User is logged in in the app
- Baseline assessment completed
- 2-weeks monitoring completed
- User has selected the pathway “Improve my Memory”
- DSS sent a new coaching activity plan including a structured activity for training the memory

5.6. Chatbot

The main goal of the chatbot is the ability of the user to have another form of companionship, friend and a coach. In particular, the chatbot role is for the user to have a natural conversation with the chatbot and to get notifications and answers. The user will be able to chat with the coach using text and buttons to tell and receive information. The user will be able to send the chatbot everyday a photo of the dish he/she is eating. The chatbot has the ability to detect the dish in the photo to give feedback back and calculates its nutrients. The chatbot will also ask the user to answer some questionnaires to evaluate the user’s wellbeing. The chatbot has a notification system to remind the user of some tasks he/she has to do. The chatbot can receive data about the user profile from the user. The chatbot has a history of the user’s conversation and the latest mood.

The chatbot is integrated in the mobile app. It is connected to the node-engine of the nestore cloud, and which is directly connected to the user profile and the DSS.

5.6.1. Requirements Pilot/user requirements for chatbot

The chatbot content should be personalized

Privacy and sharing settings should be as clear and customizable as possible and the default configuration should avoid to share any information with anyone. The system should also be very clear when these configurations are about to change.



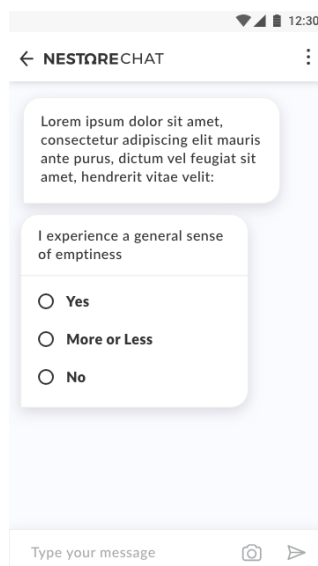


Figure 5 Chatbot design

5.6.2. Chatbot requirements & functionalities

The chatbot was built with the following main functionalities:

- The chatbot will ask the user to send him a photo of the dish the user is eating.
- The chatbot will ask the user to answer some specific domain questionnaires.
- The chatbot sends notifications
- The chatbot knows information about the user
- The chatbot remembers the user's latest mood.

The design of chatbot is like any whatsapp conversation with a human being.

5.6.3. Test Case 1 – First conversation

Main flow:

- User clicks on the button start 2-weeks phase



- The user is prompted to the home, a message appears on the top right from the chat button. NESTORE says “Hello “username”, my name is NESTORE”.
- The chatbot shows a phrase to learn how to use the chatbot and a button that the user should press
- The user presses the button, the answer is shown in the chat in orange color. Chatbot continues to speak about itself. The user can ask questions through the buttons.
- At some point, the chatbot asks to send a photo of a dish. Two icons appear in the bottom bar, a camera and a clip.
- The user taps on the clip and chooses an existing photo of a tangerine. He pushes on the send button.
- The chatbot continues explaining how it works for food recognition.
- The chatbot process the photo and replies tangerine (“ingredient”). The user confirms that is correct
- A nutritional feedback is sent
- The user is guided through tips to the calendar and the charts.

Prerequisites:

- NESTORE Coach app installed from Play Store
- User registered in the NESTORE web portal
- User is logged in in the app
- Baseline assessment completed
- The user has a photo of a tangerine in the phone (use UB photo)

5.6.4. Test Case2 – Questionnaire

Main flow:

- A notification is received in the smartphone
- The user turns on the screen and scrolls the notifications. The NESTORE notification says “do you agree to answer a questionnaire?”.
- The user clicks on the notification, the user is prompted in the chatbot. He answers yes to the question.



- A preliminary message introducing the questionnaire is shown
- 10 questions are asked to the user. The user answers 4 times yes and 6 no.
- The chatbot thanks for the answers.
- The user goes on the chart section, cognitive, domain, week view. In the tab cognitive failures, for the current weekday, the number 4 is shown, in yellow color.

Prerequisites:

- NESTORE Coach app installed from Play Store
- User registered in the NESTORE web portal
- User is logged in in the app
- Baseline assessment completed
- 2-weeks monitoring started
- Phone is in standby
- DSS send a MQTT message for a questionnaire (COG)

5.7. Sleep activity

In the sleep monitoring context, technological advances have allowed the development of non-invasive, long-life, battery powered, wearable or unobtrusive devices equipped with tri-axial accelerometers (i.e., actigraphy and ballistocardiography) able to monitor and collect data generated by movements.

In NESTORE, the main idea is to perform the evaluation of: sleep stages identification (polysomnography represents the gold standard), perceived sleep quality (sleep diaries represents the gold standard), and variables able to characterize the sleep session. For this purpose, NESTORE adopts the Ballistocardiography (BCG) technology to infer the users' sleep patterns, behaviour, and the sleep quality. In the NESTORE system, the ballistocardiography is applied using the sensor SCA11H provided by Murata company.

The chosen short-term indicators (as reported in Deliverable D4.1) are uploaded to the NESTORE back-end and made available to the DSS using the following api:

https://api.zivacare.com/api/v3/human/sleeps?access_token=<token>

to the dedicated endpoint:

human.sleep



The indicators are the following reporting dummy values (in bold the ones used by the NESTORE app to create graphs for the users):

```
"sleeps":[{
  "code": "758ed613-b9d3-4ce6-8573-b7777aadd54a",
  "id": 77,
  "day": "2014-09-16",
  "start_time": "2014-09-16T18:52:01+03:00",
  "end_time": "2014-09-17T18:52:01+03:00",
  "main_sleep": true,
  "time_asleep": 177,
  "time_awake": 12,
  "source": "nestore",
  "efficiency": 37,
  "time_to_fall_asleep": 11,
  "time_after_wakeup": 0,
  "time_in_bed": 32,
  "time_series": null,
  "perceived_sleep_quality": null,
  "sleep_quality_index": 4,
  "user_code": "e231e984-2209-4a10-b634-2257b89c200f",
  "created_at": "2015-04-07T20:48:40+03:00",
  "updated_at": null
}]
```

5.8.Social Platform

The main goal of the social platform is the possibility to share and offer knowledge and services provided by the users to other users, meaning that the social platform allows to monitor and to support the social



exchanges of the user. In particular, users with a high intrinsic capacity in one dimension (e.g., cooking skills or mobility skills) can support other users in the achievement of their goal in the respective dimension, increasing the functional abilities of the beneficiary of this knowledge or of these services. External entities, such as public institutions, enterprises, shops and communities, are also able to offer services and knowledge through this platform.

The Social platform interacts with the coach (mobile app), decision support system (calendar), serious game, and Monitoring system (NESTORE connect).

More details about Social Platform are in the deliverable D5.4 Social Platform.

5.8.1. Requirements Pilot/user requirements for Social Platform

For the developemnt of the Social Platform were used the main folowiing requirements:

- Highly customizable (Personalized)
- The Social Platform needed to allow the users to select/decide:
- The activities or the kind of activities in which they are interested
- The people (friends, family, other) from which they want to receive notifications
- The geographical areas from which they want to receive notifications
- Play the role of connector for real-life activities
- The users want to be with people, to share experiences, and to make new connections but the users strongly expressed the need to bring those social connections in real-life (i.e., not just friends on Facebook).
- Clear and safe interface for privacy settings

Privacy and sharing settings should be as clear and customizable as possible and the default configuration should avoid to share any information with anyone. The system should also be very clear when these configurations are about to change.

5.8.2. Social Platform requirements & functionalities



The design of the public pages echoes the design of the NESTORE website (<https://nestore-coach.eu>) and has a public section and a private section.

The public section is accessible to everyone, and, any visitor can access to check the public articles in the blog and participate in public discussions in the forum.

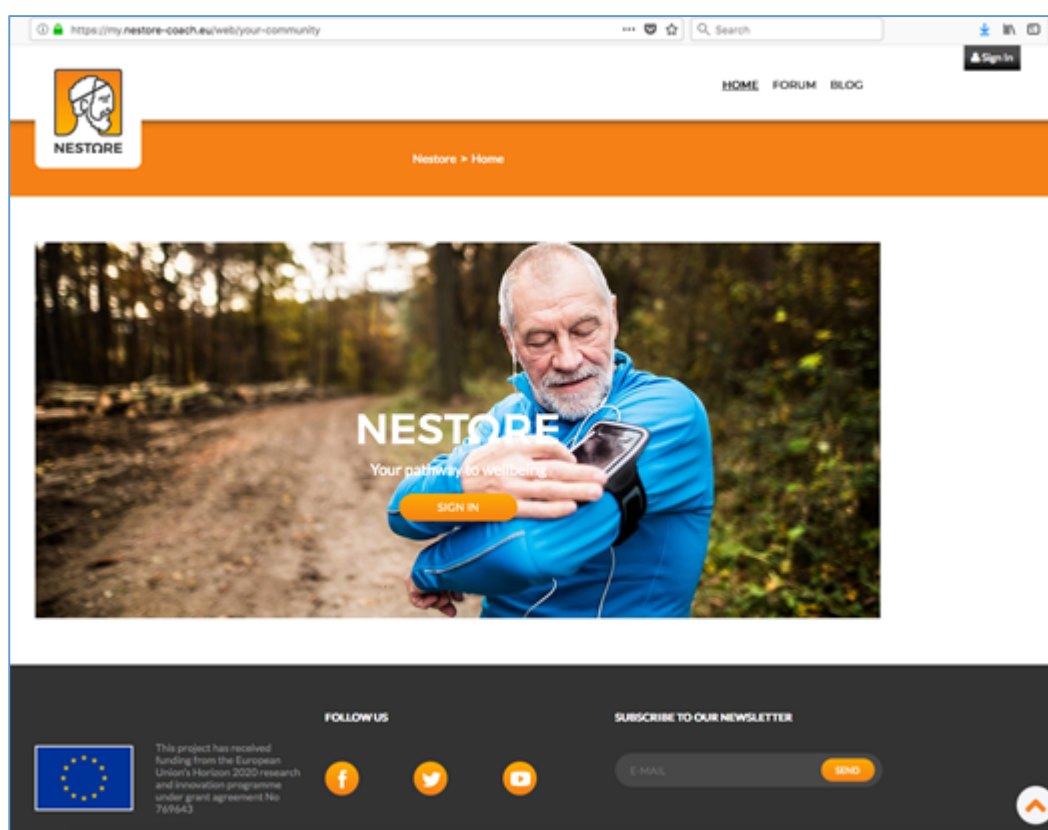


Figure 6 Home page of Social Platform

The private section can be accessed only by the users with a user account (username and password) and provide access to the many subsections:

- Blog: allowing each user to publish personal blog articles visible only by selected people.



- Forum: providing all the basic capabilities of a classic web forum (e.g., create new threads, posts, etc.) and to visualize user's statistics.
- Find Friends: allowing the user to search and identify friends inside the portal.
- ZivaCare Status: providing the possibility of synchronizing and visualize personal data coming from NESTORE Monitoring System through NESTORE Connect.
- Places and Events - allow the possibility to share and offer knowledge and services provided by the users to other users
- View all the available offers
- Add new offers
- Comment existing offers

Considering the outcomes of the workshops, all these offers are related to a specific geographical place. In this way, the users will be able to explore the activities in the areas of interest that they selected.

5.8.3. Test-case 1: Register on the Social platform

Main flow

1. Access the page my.nestore-coach.eu
2. Click on the **Sign In** box on the right of your screen

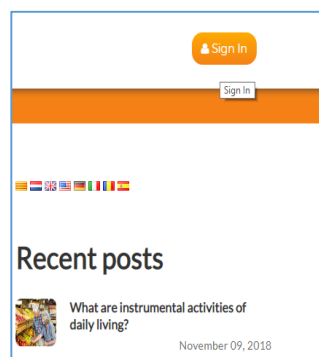
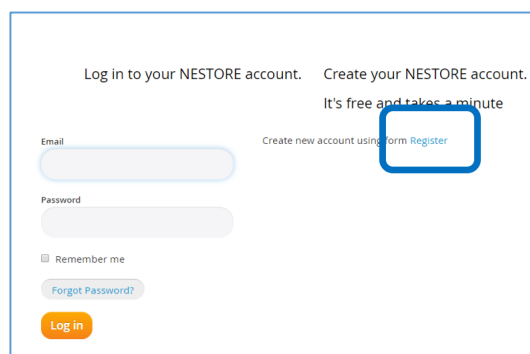


Figure 7 Social Platform Sign In screen



3. If you DO NOT have an account, click **Register**.



Log in to your NESTORE account. Create your NESTORE account.
It's free and takes a minute

Email Create new account using form **Register**

Password

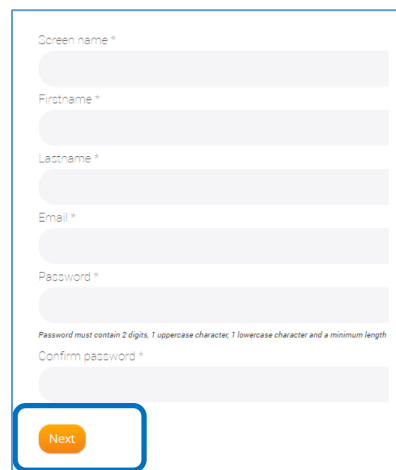
Remember me

[Forgot Password?](#)

Log in

Figure 8 Social Platform Sign In/ Register screen

4. Fill in the fields and then click **Next**. Each field with a * is required.



Screen name *

Firstname *

Lastname *

Email *

Password *

Password must contain 2 digits, 1 uppercase character, 1 lowercase character and a minimum length

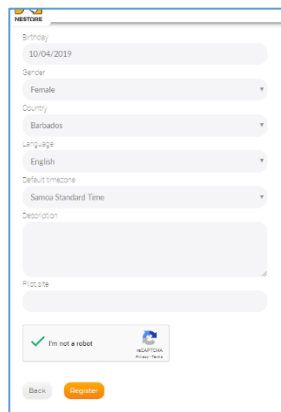
Confirm password *

Next

Figure 9 Fields for register

5. Continue to **fill** in the fields, **check** the "I'm not a robot" and then click **Register**.





The screenshot shows a registration form for NESTORE. The fields are filled with the following information:

- Username: Simdaly
- Date of Birth: 10/04/2019
- Gender: Female
- Country: Barbados
- Language: English
- Default timezone: Samoa Standard Time
- Description: (empty)
- Profile photo: (empty)

At the bottom, there is a checkbox for "I'm not a robot" which is checked, and a "REGISTER" button. There are also "Back" and "REGISTER" buttons at the very bottom.

Figure 10 Fields completed for register

- The message "Your account has been created. Please go to Sign In page." will appear on your screen.

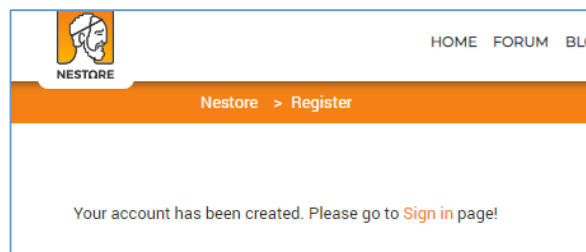


Figure 11 "Your account has been created" screen

- Click **Sign In** link
- Enter your credentials (the same credentials used for the NESTORE app), click **Log in** and...that's it.

Alternative flow

none

Preconditions



Access on the internet

Post conditions

The user will have a viable account that will allow to share knowledge, exchange data, visualize the personal data regarding physical activities, social, calendar.

5.8.4. Test-case 2: How to approve new places on the directory

Main flow

1. Go to <https://my.nestore-coach.eu/directory/wp-admin>
2. Fill your credentials, username and password, and then click **Log In**.

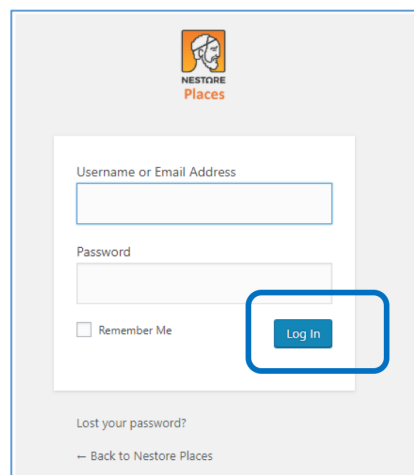


Figure 12 Log In screen for Places

3. The Dashboard page opens.

Go to Places on the menu and click Places to see all the places, including published and **pending**.



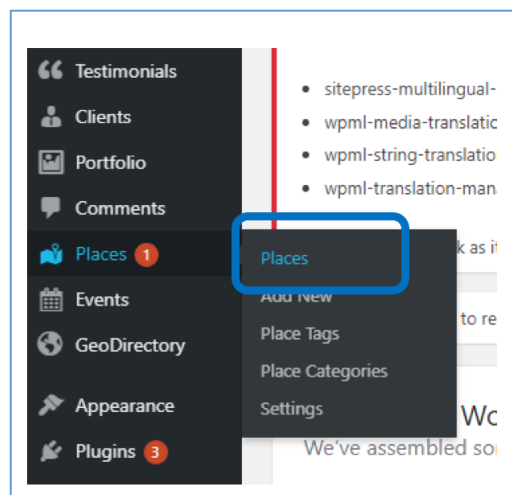


Figure 13 "Places" on the menu

4. To approve a pending place, click **edit** and then **publish**, on the right of your screen



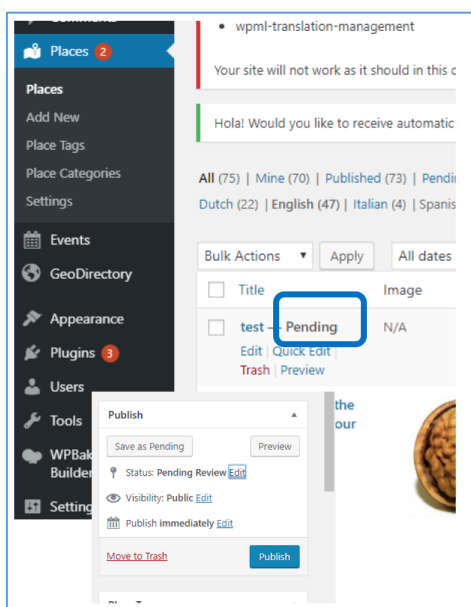


Figure 14 Approve a pending place

5. If the new place must be added to one of the **Dutch, Spanish** or **Italian** pages, you can choose which one you want from the top flag. After publishing the place on English, **check** the language you want, click **duplicate**, and then click **Update**.



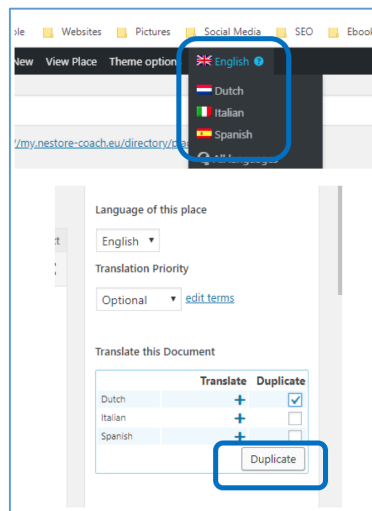


Figure 15 Duplicate an event in other languages than English

6. Go to **Places** again, go to the **flags**, choose the language you duplicated the published place, and click on it. (let's say you chose Dutch when you clicked on duplicate, now you must choose the Dutch flag).

The list of all places for Dutch opens. Click on the one you approved earlier.

The page of the place opens.

7. Click Translate independently and then Update.



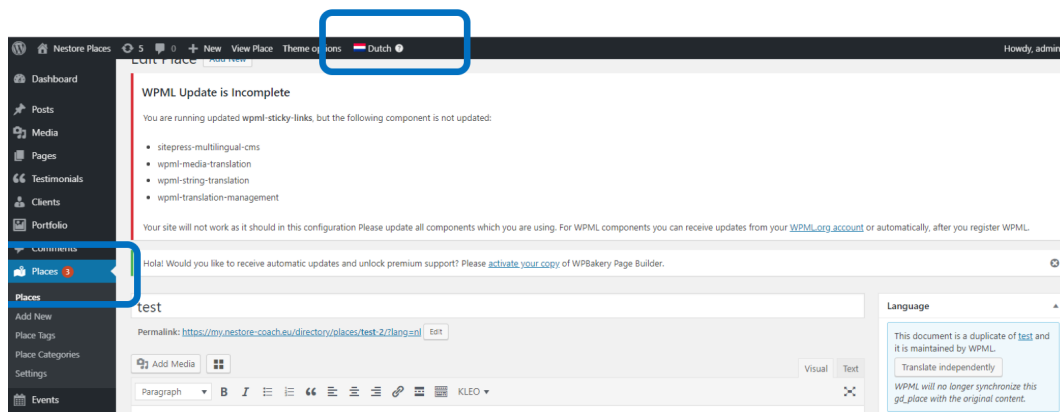


Figure 16 Places - translate Independently

5.8.5. Test-case 3: How to add information on My Profile

Main flow

1. Go to <https://my.nestore-coach.eu/>
2. Once you are on the NESTORE page click on the **Sign In** box on the right of the screen. To add information on My Profile the users must be logged in.

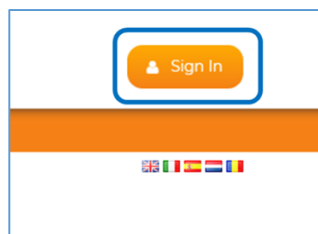


Figure 17 Sign In screen for Nestore account

3. Once logged in, click on the main menu (on top of the page) **Dashboard**.



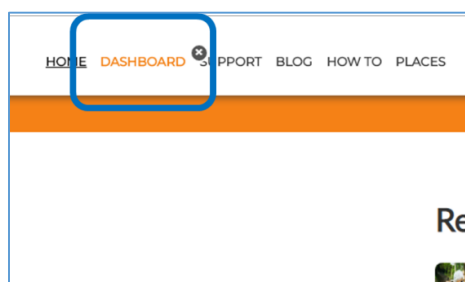


Figure 18 Dashboard entry screen for Nestore account

4. The **Dashboard** page opens. From here, click **My Profile** to access all the section's areas.

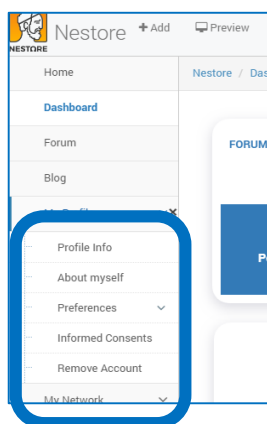


Figure 19 My Profile entry screen for a logged in user on Nestore platform

5. It's time to add information. On **Profile** info, if you want to add more information, click **More**. Once you finished adding useful information click **Submit**.



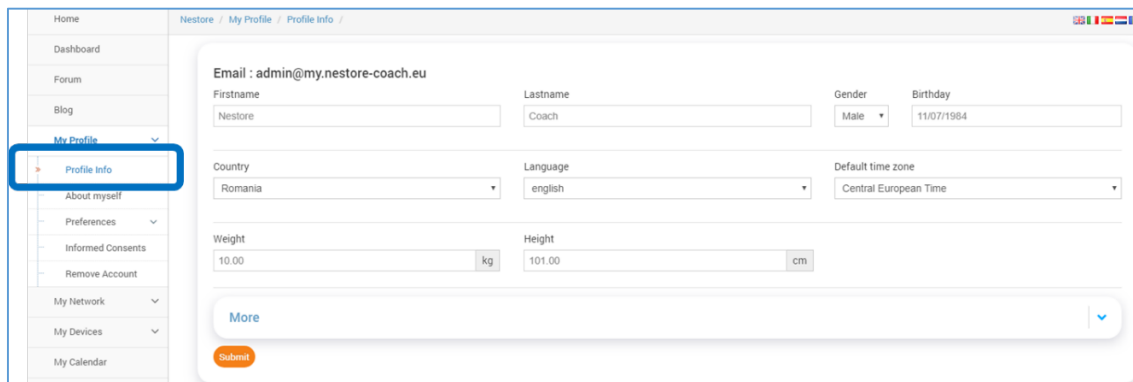


Figure 20 Profile info entries screen for a logged in user on Nestore platform

6. Continue adding information on the next sections **About Myself** and **Preferences**.

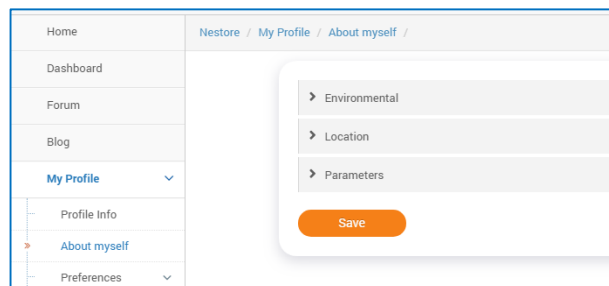


Figure 21 About Myself and Preferences entries screen

7. Last two sections inform the user about data security, permissions and GDPR.



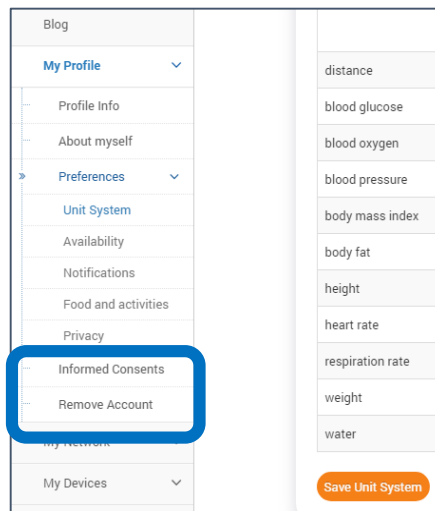


Figure 22 Informed Consent and Remove account entries screen

5.8.6. Test-case 4: How to add an event to My Calendar

Main flow

1. Go to <https://my.nestore-coach.eu/directory/>
2. Once you are on the NESTORE Places page click **Login** on the right of the screen.

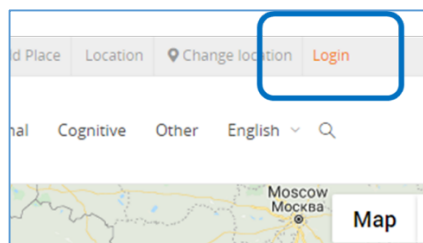


Figure 23 Login screen for Nestore Places



- Once logged in, feel free to check out all the recommendations. When an event is interesting enough, the user can **add it to its calendar**.

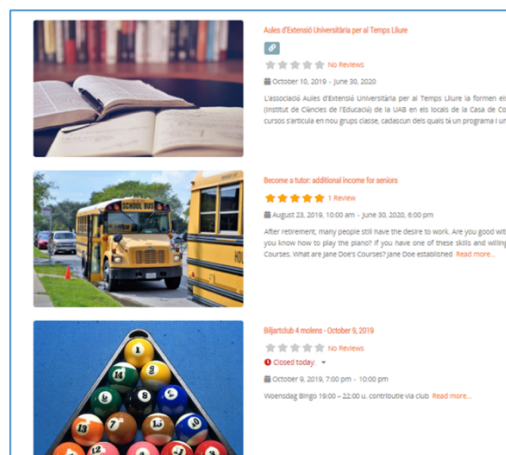


Figure 24 Events screen for Nestore Places

- How to do that? Just click on the event. A new page opens with all the details. On the right side of the screen one sees the **Add to my calendar** box.





Figure 25 Event screen with calendar integration for Nestore Places

5. How to do that? Choose the date, hour and duration, and then click **Add**. Then you can click **Open My Calendar** to check your favorite event.

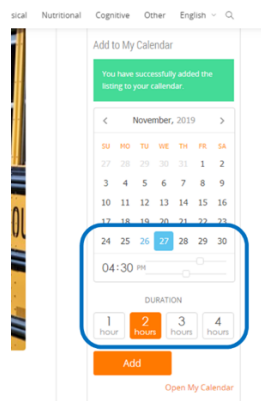


Figure 26 Calendar integration confirmation for Nestore Places



6. Decision Support System

6.1. Test-case 1: DSS – Pathway selection

Main flow

This flow starts when the user has finished the 2 weeks phase, in which the DSS gathers the necessary information to evaluate the user in the four domains of NESTORE. It exactly starts in the afternoon of pilot day 14.

1. The DSS runs a rule-based reasoning system to evaluate the user in the four domains. The most convenient sub-pathway for every domain is stored in the DSS user profile. The results appear in the DSS log.
2. The module 'tasks scheduler' sends an alarm to the e-coach app to inform the app about the availability of the pathway selection. It is done through MQTT publishing on topic 'dss/'+userid+'/questions2/PATH'.
3. The e-coach app reads the alarm and does a GET in 'dss/possiblepathways/<userId>' endpoint, which returns the results of Step 1.
4. The e-coach app does a POST in 'dss/currentpathway' endpoint, in which the DSS is informed about the pathway that the user finally selects through the interface.

The DSS updates the information in the DSS MongoDB database. Check the results in the DSS MongoDB – collection 'users' – field: 'pathway'.

Alternative flow

This flow applies when there is not enough data of one sub-domain. For example, do not perform the '6 minutes walking test'.

1. In day 14, at night, the DSS runs a rule-based reasoning system to evaluate the user in the four domains. The results appear in the DSS log.
2. The DSS realize that there is not enough data to run the algorithms properly. Check the DSS user profile – collection 'users' – field 'baseline': '6mwt'. It is empty.



3. The DSS sends an alarm through MQTT to the e-coach informing that there is no data about that particular field.
4. Wait 24 hours, and check again in the DSS user profile. Test these two options:
 - There is data. The Main flow will start normally.
 - There is still no data. The Main flow will start, but Physical activity will not be evaluated.

Preconditions

- The installation of all the sensors has to be performed;
- The installation of e-coach app has to be done;
- The user had to perform all the baseline tests;
- The user had to follow the 2 weeks phase replying and performing the questionnaires and tests proposed by the system;
- The DSS user profile has to be completed. Check its status in DSS MongoDB database – collection ‘users’ – field baseline.

Post conditions

- The DSS user profile will be updated with the pathway information selected by the user. Check the status in DSS MongoDB database- collection ‘users’ – field pathway.
- The phase of the user will be updated. Check the status in DSS MongoDB database – collection ‘users’ – field ‘working-memory: stage’.
- The e-coach app will be personalized according to the selected pathway.

6.2.Test-case 2: DSS – Weekly plan (structured activities recommendations)

Main flow

1. Every night at 2:00 am, the DSS evaluates which users need to be proposed with a new weekly plan. Check the DSS log to see the identifiers of the users that are being evaluated tonight.
2. The DSS decides which structured activities are more convenient for the user, and stores the recommendations in the DSS MongoDB database. Check the DSS database – collection ‘coaching_structured’; check that all fields are coherent.



3. The structured activities planned by the DSS will appear in the e-coach app, more precisely, in the 'New activities' tab. Choose one of them and schedule it through the interface.
4. Go again to the DSS database- collection 'coaching_structured'- field: 'scheduled' and 'scheduled time', and check that it is coherent with the time that you put through the interface.
5. 30 minutes before the scheduled time, the DSS will inform the e-coach about the structured activity. Check that the reminder is sent by the DSS by checking the DSS log. Afterwards, verify that the reminder is shown by the e-coach app.

Alternative flow

This flow applies when it's the first time that a weekly plan is sent to the user.

1. When the user selects a pathway through the POST described in Step 4 of the Main flow of 'Pathway selection' use-case, the weekly plan is calculated straight away. Verify it by selecting the pathway and checking that the weekly plan of the first week appears in the e-coach app.

Preconditions

- All the preconditions of the 'Pathway selection' test applies.
- The user has to be in the 'intervention phase'. Check the status in the DSS user profile – collection 'user' – field: 'working-memory: stage'.
- The user has to have a preferred day to send weekly plans. It has to be set in the DSS user profile – collection 'user' – field: 'working-memory: planDay'.
- The user has to have a selected pathway. Check it in the DSS user profile – collection 'user' – field: 'pathway'.

Post conditions

- The recommended structured activities have to appear in 'New activities' tab of the main screen of the e-coach app.

6.3.Test-case 3: DSS – Aerobic Fitness 4 weeks' assessment



Main flow

1. After 4 weeks of intervention, check that the user is in the 'intervention' phase, and in pilotDay 28 by going to the DSS MongoDB – collection 'users' – fields: 'working-memory: stage and pilotDay'.
2. Check the training adherence and the last results of the 6 minutes walking test by going to Zivacare API – human collection.
3. Check the Mean of RPE and TQR by going to the DSS MongoDB – collection 'coaching-structured' – field: 'review'.
4. Follow the description of the algorithm specified in D4.4. – section 4.4.1*: Four weeks' assessment to verify that the alarms sent to the user to propose a change of the group are coherent with the results seen in Step 2 and Step 3.

*For each of those users, take the ones that are in the improve group and check if they have improved or not through the clinical aerobic fitness assessment (taking the 6mwt of the last 4 weeks).

- a. For the ones that have improved, send a notification to the e-coach, so that the chatbot can ask the user if they want to change to the "retain" group, or they want to continue with the coaching plans of the "improve" group.
- b. If they want to change, adapt the database accordingly and stop this workflow.

For the users that have not changed, get training adherence mean and check:

- If training adherence is lower than 25%, the DSS sends an MQTT message to the e-Coach, so that the chatbot can ask the user what is the problem: the training frequency, the training intensity or both. When the DSS receives the response, it modifies the coaching plans accordingly.
- If training adherence is between 50% and 25%, the DSS sends an MQTT message to the e-Coach, with the topic 'alarm', so that the chatbot can show a warning to the user.

For the users that haven't changed, evaluate fatigue and recovery:

- Get the mean score of the results from TQR from the last week and, if it's lower or equals to 12, reduce training intensity.
- If no change has been done in the last point, get demean score of the results from the Borg scale from the last week and, if it's higher or equals to 15, reduce training intensity.



Alternative flow

There is no alternative flow.

Preconditions

- All the preconditions stated in the test-case about ‘pathway selection’ apply to this test.
- The user has to select the pathway ‘Aerobic Fitness’.
- The user has to had performed the intervention for 4 weeks.

Post conditions

- The results of the algorithm will be shown through a conversation in the chatbot. Verify it in the e-coach app.

6.4. Test-case 4: DSS – Calculation of nutritional information given a photo

Main flow

1. Take a photo of your meal through the e-coach app and follow the instructions given by the app to select the most convenient dish.
2. Check the data stored by the DSS going to the DSS database – collection ‘photos’ – all fields. Verify that they are coherent.
3. Send the calculated nutritional information to the expert in nutrition (1 per partner).

Alternative flow

The user can also add a photo from his phone library. For example: if he/she is in a restaurant and doesn’t want to upload immediately the photo of the dish, he/she will be able to do it later, picking up the photos in the library.



Preconditions

- All the preconditions stated in the test-case about 'pathway selection' apply to this test.
- The user has to select the pathway 'Achieve a healthy diet'.

Post conditions

- The results of the calculations will be shown in the e-coach app.



7. Serious game

The goal of serious games is to engage users in training their physical and cognitive health. It offers exercises in both these dimensions, encompassed by a motivating gamified system. Detail about the requirements and design of the serious games can be found in deliverable D5.5 Serious Games for Engagement and Well-being.

Serious games interact with the coach (mobile app), decision support system (indirectly), and social platform.

7.1. Game Functionalities for Pilot

During the pilot, users need to be able to use the game for the following:

- Download game from app store
- Login to game with NESTORE account
- Go through physical exercise routine
- Play cognition game
- Use stars and coins earned by playing to decorate their ship
- Visit ships from friends

7.2. Test-case 1: Download

- Open Google Play Store
- Search for “NESTORE Pocket Odyssey”
- <https://play.google.com/store/apps/details?id=com.tud.NestorePocketOdyssey>
- Install the game on the phone



7.3. Test-case 2: Login

Open NESTORE Pocket Odyssey app

1. Fill in email and password (need a NESTORE account first)
2. Select language
3. Press login
4. Follow tutorial (in case of first time login)

7.4. Test-case 3: Physical exercise routine

1. Press the green button in the bottom right of the screen
2. Select 'Gym' on the left
3. Choose exercise type: Strength, flexibility or balance
4. Choose light or moderate session
5. Press the 'Settings' button in the top left to see information on weights
6. Press start and follow along with exercise
7. Repeat for all exercises
8. Continue to next set or stop
9. Fill in BORG scale by moving the slider and press continue

7.5. Test-case 4: Cognition game

1. Press the green button in the bottom right of the screen
2. Select 'Submarine' on the right
3. Choose practice session or press 'Play'



4. Memorize the route shown, press green button to start
5. Move the submarine by tilting the device, press the correct direction on crossroads, tap the screen to collect coins. The game will finish when the submarine reaches the end of the route.
6. Press continue on the score screen to finish

7.6. Test-case 5: Decorate ship

1. When coins and stars have been collected (from Gym or Submarine), press 'List' button in the bottom left of the screen
2. Press the green button to unlock the next part of the ship
 - a. Alternatively, click on a previously unlocked object to change the décor option
3. Choose an option and press the green checkmark to buy

7.7. Test-case 6: Visit ship

1. Click on the 'Cup' button in the top right of the screen
2. See a list of your friends on the NESTORE social platform
3. Tap one of the names to visit that friend's ship
4. Press the return button in the top right to go back to own ship



8. Integrated Testing plan for NESTORE system

After performing component tests by carrying out the use cases described in the previous chapters, the consortium agrees on starting the integration testing phase. The plan consists on testing all the modules and components of NESTORE system when integrated to verify that they work as expected, so that can be checked that all modules and components which are working fine individually do not have issues when integrated.

In a large and complex system as NESTORE, which involves the combination of many modules which are tightly coupled with each other, using black box testing technique is the most recommended approach. The main objective of this kind of testing is to test the interfaces between the different modules, checking the behaviour of all them working in combination, and validate whether the requirements and scope of the system are implemented correctly or not.

8.1. Set up of the integrated tests

In the following sections, we describe the process carried out to set up all the elements needed to perform the integrated tests. Some challenges are foreseen, namely:

- Not only the connection between modules i.e. interfaces and APIs should be tested, but an exhaustive testing considering the context and the different workflows as a whole should be done to ensure that the integrated system works properly. Therefore, it's agreed to write a testing protocol that considers the different paths and permutations.
- Managing Integration testing becomes complex because a lot of environments are involved in it like different databases, applications, hardware etc. In NESTORE, all technical partners are required to be involved in these tests and periodically check the issues encountered by other partners while using the system.
- Integrating several different systems developed by different partners is a big challenge as for how one of the systems will impact the other system if any changes are done. It's because of this challenge that a chatting group is set up, so that conversations about changes, problems and improvements are explained to all the involved partners in the moment that they are taking place. This simple system is really helpful in the sense that all partners are informed about the evolution of the testing and the consequent changes that are being done.

The following steps were done to perform the planned integrated tests.



8.1.1. Beta testers recruitment

Both technical partners and partners in charge of piloting were invited to behave as end users during December 2019 and January 2020. Different partners showed their interest to become beta testers during the steering boards that took place the weeks before. Those beta testers were provided with the kits containing all the hardware, the necessary instructions to install the kits and the testing procedure. Because of logistical reasons, volunteers were asked to respect the dates listed in Table 1.

Table 1. Integration Testing phase important dates

Maximum starting date for integration tests	January 7th
Sensors shipment back to Flex	January 16th
Stop Testing & start preparing databases	January 24th

8.1.2. Distribution of kits

In this phase, FLEX sent 20 kits in total to several consortium partners for integration testing purposes. The distribution of kits sent can be seen in Table 2.

Table 2. Distribution of the NESTORE kits among partners for testing purposes.

Partner	Number of kits
EURECAT	6
Fundació Salut i Envel·liment	2
HES-SO (*)	2
NEOS(*)	1



Preventie Collectief	2
ROPARDO	2
POLIMI	2
CNR-ISTI (*)	1
MERIDIANA	2

(*) The marked partners received a partial kit, meaning only some specific devices to run dedicated testing or keep developing.

Each kit was composed of the necessary devices:

- tangible interface and cables
- bracelet (with charge station)
- beacons (environmental and social) and batteries
- smart scale
- sleep monitoring device
- flexibility assessment tool

while the mobile applications were downloaded.

8.1.3. Installation procedure and manuals

During the Integration meeting carried out in Rotterdam on 03/10/2019, partners realised that, given the complexity of NESTORE system, it would be necessary to write a document pointing out the steps to be followed to complete a full installation. This document also contains who is responsible of doing each step.

Social Domain manuals

In order to better describe the installation procedure of social beacons, 2 documents support the installation: “installation manual” and end “user manual”. Documents have been translated to:



- Italian
 - <https://nestore-coach.eu/documents/20182/140062/Social+Beacon+-+installation+manual.en.it.docx/c22b7820-ef93-4ddb-bda2-95f5fe0083fb>
 - <https://nestore-coach.eu/documents/20182/140062/Social+Beacon+-+user+manual.en.it.docx/4417ce12-0bd5-4ea4-99b2-c6ae9ca1aad2>
- Dutch
 - https://nestore-coach.eu/documents/20182/140057/Social+Beacon+-+installation+manual_Dutch.docx/71542798-a1a7-4686-8282-39daacbb688c
 - https://nestore-coach.eu/documents/20182/140057/Social+Beacon+-+user+manual_Dutch.docx/a5630fcb-cef2-4e8d-a9c3-5bdca5810e06
- Spanish
 - https://nestore-coach.eu/documents/20182/140052/Social+Beacon+-+installation+manual_spanish.docx/f8e578fe-a166-494c-924f-02de8a6319c5
 - https://nestore-coach.eu/documents/20182/140052/Social+Beacon+-+user+manual_spanish.docx/a3d16406-15e5-410e-8e51-fb4339275405

8.2. Testing procedure

The testing procedure was defined in two steps: first was defined the test tasks that had to be carried out and later was composed the testing protocol using the lessons learned in the first step.

8.2.1. Test tasks

Prior to execute the integrated tests, with the goal of assuring the correct basic functioning of the system, we brainstormed to list all the tasks that had to be performed to explore all the connections among the NESTORE modules, such as checking that data was properly gathered by the sensors and correctly stored in the cloud.



Test tasks				Download	Wearable	WoT agent	Indicators	Smart scale	Social beacons	Env. Beacons	Murata	Cloud
✓	Date	Task	Problems detected									
✓	06/09	Download WoT agent and sign-in with Carles Pau		█								
✓	06/09	Download Game and sign-in with Carles Pau	Spanish not available for testing. We couldn't find the game in Play Store.									
✓	06/09	Download Health Mate and sign-in with Carles Pau										
✓	12/09	Download NESTORE app and sign-in with Carles Pau	It's not public. We got the last apk.	█								
✓	06/09	Get the smart scale					█					
✓	06/09	Pair Bracelet with WoT agent	Issues with mobile phone's Bluetooth		█							
✓	06/09	Get data from social beacons	Issues with mobile phone's Bluetooth					█				█
✓	04/09	Installed Murata on a bed									█	
✓	12/09	Sync data from WoT to cloud				█						█
✓	12/09	Check data in cloud (dev): environmental beacons							█			█
✓	12/09	Check data in cloud (dev): social beacons						█				█
✓	12/09	Check data in cloud (dev): game beacons										█
✓	12/09	Check data in cloud (dev): wearable			█							█
✓	12/09	Check data in cloud (dev): smart scale					█					█
✓	12/09	Deploy environmental beacons							█			█
✓	12/09	Deploy social beacons						█				█
✓	12/09	Register in NESTORE	Couldn't test because it was already done									█

Figure 27 shows a snapshot of the aforesaid document.

These test tasks helped us to detect very basic flaws, such as the realization of not having a public repository with the latest version of the eCoach app. This was soon solved by deploying the latest version of the eCoach app in a shared Drive folder. The corresponding app apk has been accessible since then by using the same URL.



Test tasks				Download	Wearable	WoT agent	Indicators	Smart scale	Social beacons	Env. beacons	Murata	Cloud
✓	Date	Task	Problems detected									
✓	06/09	Download WoT agent and sign-in with Carles Pau		█								
✓	06/09	Download Game and sign-in with Carles Pau	Spanish not available for testing. We couldn't find the game in Play Store.									
✓	06/09	Download Health Mate and sign-in with Carles Pau										
✓	12/09	Download NESTORE app and sign-in with Carles Pau	It's not public. We got the last apk.	█								
✓	06/09	Set the smart scale					█					
✓	06/09	Pair Bracelet with WoT agent	Issues with mobile phone's Bluetooth		█							
✓	06/09	Get data from social beacons	Issues with mobile phone's Bluetooth					█				█
✓	04/09	Installed Murata on a bed									█	
✓	12/09	Sync data from WoT to cloud				█						█
✓	12/09	Check data in cloud (dev): environmental beacons							█			█
✓	12/09	Check data in cloud (dev): social beacons							█			█
✓	12/09	Check data in cloud (dev): game beacons							█			█
✓	12/09	Check data in cloud (dev): wearable			█							█
✓	12/09	Check data in cloud (dev): smart scale					█					█
✓	12/09	Deploy environmental beacons							█			█
✓	12/09	Deploy social beacons							█			█
✓	12/09	Register in NESTORE	Couldn't test because it was already done									█

Figure 27. Snapshot of the test tasks.

8.2.2. Testing protocol

The testing protocol including all the steps that have to be followed to test all the workflows and combinations of NESTORE System are listed in Table 3. Initial questions asked to internal test participants. Partners that expressed their willingness to participate were provided with a version of this document with an extra column called 'Actual Output', where they could express their comments and/or errors observed while performing the tests.

Before proceeding with the tests, participants were asked to fill in Table 3.

Table 3. Initial questions asked to internal test participants

e-mail:	
---------	--



<i>starting date:</i>		
	Installed? Yes / No	Version
social beacons (5)		
environmental beacons (5)		
sleep monitor		
wearable		
Coach app		
NESTORE Connect		
Pocket Odyssey		
Health Mate		
Tangible Coach		

Table 4. Testing protocol

Use Case #	Task #	Description	Expected output
1. Registration			
	1.1. Create new account	Go to https://my.nestore-coach.eu/web/your-community/register and create a new account. Write "User Code" =letter + 3 numbers (random!)	
	1.2 Sign in	Go to https://my.nestore-coach.eu/ and click Sign in button. Insert your e-mail and password.	Redirected to Home page. Your name will appear in the top right of the screen.
2. Coach app - Log in and baseline			



	2.1. Sign in	Sign in with the credentials you created in the webapp	Baseline tasks screen will appear
	2.2. Numerical Updating Task	Do the Numerical Updating task	NUT Tutorial appear. After doing it, in the main screen you will see 1/12
	2.3. N-Back	Do the N-Back	2-Back Trial appear. After doing it, in the main screen you will see 1/6
	2.4 Questionnaire on Loneliness	Reply to the questions	6 questions will appear. After doing it, in the main screen you will see an orange 'tick'.
	2.5 Questionnaire on social integration	Reply to the questions	6 questions will appear. After doing it, in the main screen you will see an orange 'tick'.
	2.6 Questionnaire on cognitive failures	Reply to the questions	25 questions will appear. After doing it, in the main screen you will see an orange 'tick'.
	2.7 Skip baseline phase	Press "Skip baseline phase" button. Inform your testing researcher that you have completed this part.	Main NESTORE screen will be showed
3. Exploring the app	3.1 Explore NESTORE app	Explore the app and take notes about your thoughts.	N.A.
4. '2 weeks' phase	4.1 Reply to questionnaires	You will receive questionnaires and tests through NESTORE chatbot during the first 2 weeks.	Chatbot will speak to you



	4.2. Add photos of your meals	When prompted by the chatbot, add photos of your meals during the day.	The app will teach you on how to use the tool to add photos of your meals. After adding a photo, the nutrients will be calculated and a brief feedback will be shown.
	4.3. Play with the game	When prompted by the chatbot, open the Pocket Odyssey game and play.	The app will teach you on playing with the game.
	4.4. Use the tangible (1st time)	In the chatbot a notification will appear explaining how to interact the first time with the tangible. Turn the tangible and say "Nestor"	The coach will start to introduce itself. Put back the coach in upright position at the end
	4.4b. Use the tangible (daily assessment, 3 per week)	In the tangible, LEDs will start showing a rainbow notification. Turn the tangible and say "nestor"	The coach will prompt you with a question about your feelings. Answer with a sentence about your feelings today. The tangible will tell you the recognized emotions.
	4.5 Perform the 30s chair rise test	When prompted by the chatbot, press 'Start' button and follow the indications to perform the test.	The app will be connected with your device. The device will show an image and the test will start.
	4.6 Perform the 6min. walking test.	When prompted by the chatbot, press 'Start' button and follow the indications to perform the test.	The app will be connected with your device. The device will show an image and the test will start.
	4.7 Perform the flexibility test	When prompted by the chatbot, follow the	The chatbot will ask you about the results of: "Sit and reach test" and "Back stretch test"



		indications to perform the test.	
	4.8 Select your pathway	After 14 days, you will be prompted with the pathway selection interface. Follow the instructions to select it.	"Choose your pathway" screen will appear. The interface will show you how to select the pathway that you will follow during the next 3 months. After selecting it, the selected pathway will be shown in the main screen of your interface.
5. Intervention phase	5.1. Weekly plan	When you receive the weekly plan, schedule the proposed activities following the indications.	A weekly plan will appear in "New activities" tab.
	5.2. Check your upcoming activities in the Social domain	Go to the second tab of the menu (agenda) and check the scheduled activities.	The scheduled activities of this domain.
	5.3. Check your upcoming activities in the physical activity domain.	Go to the second tab of the menu (agenda) and check the scheduled activities.	The scheduled activities of this domain.
	5.4. Check your upcoming activities in the nutritional domain.	Go to the second tab of the menu (agenda) and check the scheduled activities.	The scheduled activities of this domain.
	5.5. Check your upcoming activities in the cognitive domain.	Go to the second tab of the menu (agenda) and check the scheduled activities.	The scheduled activities of this domain.



	5.6. Register your water intake	Go to the '+' button and register the quantity of water that you take during the day.	The correct value of the registered water.
	5.7. Perform one physical activity of the list	Go to the '+' button and perform one of the activities of the list. Write the time on the comments column of this file. Check your fitness score before and after the activity in the weekly charts.	After stopping the activity, the activity will appear in the chart details and the score will be updated according to the duration and intensity of the activity (some delay might be needed before the update)
	5.8. Check your progress in the Social domain	Note the time spent with people to whom you gave the tag and your answer to the social questionnaire. ask the tangible about your score.	The answers to your questions will appear in the social charts (Self-reported). The time spent with the tagged people will be reported in My Local circles. The tangible will tell you the number of activities done over those suggested
	5.9. Check your progress in the physical activity domain.	Note the steps reported in the bracelet before charging. Note the training activity session performed (Aerobic or strength) ask the tangible about your score (best if at the end of the week, so that it will match the data displayed in the charts). ask the tangible about your score.	Steps will be reported in the physical domain (in daily and weekly charts, delay up to 4 hours). Structured activity training will be reported in the details of the daily structured activity. In the weekly and monthly charts the total score will be updated. The tangible will report you the score of the last 7 days, it should be consistent with the data reported in the charts.



	5.10. Check your progress in the nutritional domain.	Take photos of all your food for some days in a row. (weight management) Check at the end of every day the chart on energy balance. (healthy diet) check the nutrient intake, ask the tangible about your score. (muscle mass) check your protein intake. Ask the tangible about your score	Report in the comments the data collected. For weight management, the energy expenditure and intake will be aligned (+/-500 if you need to increase/decrease weight). Protein intake will be in the suggested range. The threshold is dynamic, report it in the comments. The tangible will report a score that is coherent with the charts. For healthy diet, it will report the number of fruits or vegetables (information not present in the charts).
	5.11. Check your progress in the cognitive domain.	Answer cognitive questionnaire. Note the answers in the comments. (improve memory) play the numerical updating task. Ask the tangible about your score	The self reported score will be shown in the memory failure chart. (improve memory) Average accuracy and task version (number of cells) is reported in the charts (currently no charts for the other pathways). The tangible will report (improve memory) your average accuracy, (broadening thinking skills) level in the game, (everyday mental skills) activities done over those suggested.
	5.12. Recommendation of unstructured physical activities	In case the system decides so, a recommendation to perform an activity will be prompted through the chatbot.	A recommendation will appear in the chatbot.
	5.13. Recommendation of unstructured nutritional activities	In case the system decides so, a recommendation to perform an activity will be prompted through the chatbot.	A recommendation will appear in the chatbot.



	5.14. Recommendation of unstructured social activities	In case the system decides so, a recommendation to perform an activity will be prompted through the chatbot.	A recommendation will appear in the chatbot.
	5.15. Recommendation of unstructured cognitive activities	In case the system decides so, a recommendation to perform an activity will be prompted through the chatbot.	A recommendation will appear in the chatbot.
	5.16. Review of activities	At night, some questions about the activities you performed will be prompted.	The chatbot will ask if you enjoyed the activity 1-5. If 3 or less will ask why. it will provide motivational message according to your answer. In case of unstructured activities, it will ask if you did the recommended activity. If not it will ask why and provide recommendations.
	5.17. Aerobic fitness structured activity (only in case that aerobic fitness is selected)	In case the system decides so, a recommendation to perform an activity will be prompted through the chatbot.	A recommendation will appear in the chatbot.

8.3. Tracking of issues

Keeping a database of the flaws encountered in the NESTORE system was key to swarm and speed up the software and algorithm improvement. For that purpose, we used GitLab, a computer software package that



manages and maintains lists of issues. In this context, an issue is a unit of work to accomplish an improvement in a system. It could be a flaw (commonly named bug), a requested feature, missing documentation, etc. Each issue reported contained a description of the problem, the solutions attempted, the application version (if relevant), and, when necessary, the ID of the user.

In Figure 28 you can see a snapshot of the GitLab used for tracking issues.

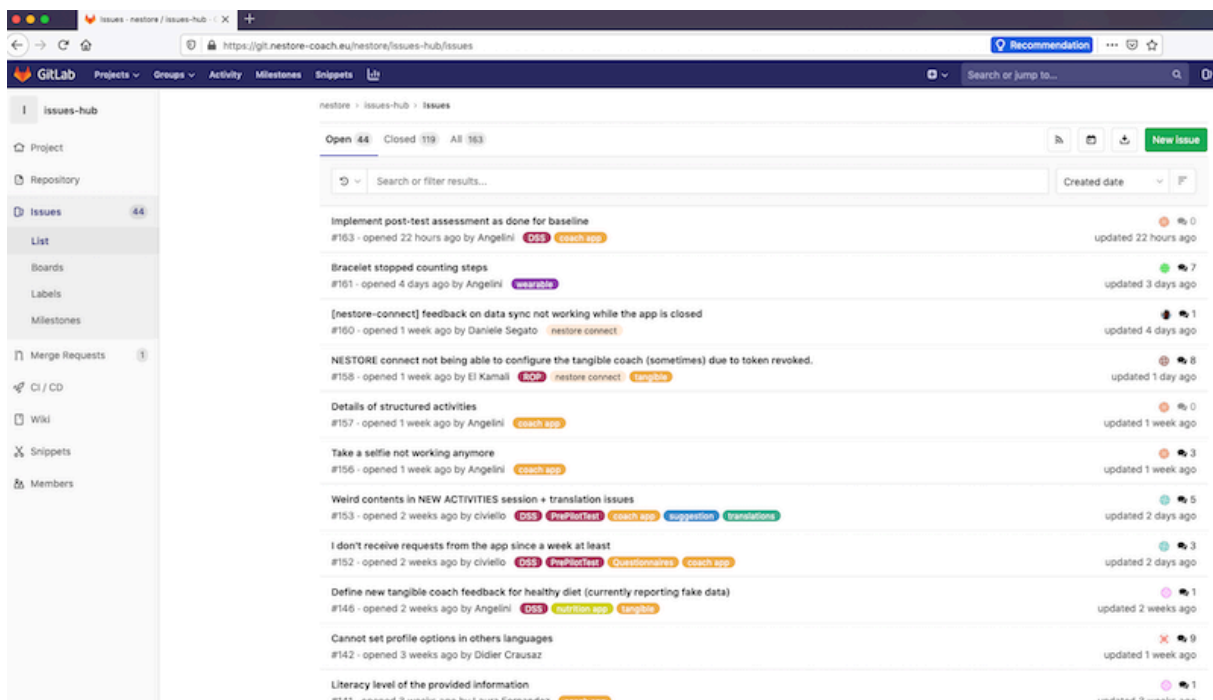


Figure 28. Overview of the GitLab issues.

In order to ease the identification and categorization of the issues reported, we came up with a number of labels. These helped to distribute the work and fostered the fast collaboration among partners.

Statistics about the issues reported in GitLab is presented in Table 5 split by these aforementioned labels.



Table 5. Statistics about the issues reported in GitLab separated by label.

Labels	Open issues	Closed issues	All
sleep	1	3	4
coach app	11	35	46
wearable	1	5	6
nestore connect	0	9	9
tangible	1	4	5
nutrition app	4	31	35
critical	1	9	10
PrePilotTest	2	17	19
Questionnaires	2	7	9
translations	1	9	10
chatbot	2	11	13
Serious game	1	6	7
DSS	5	18	23
ROP	3	25	28
sleep	1	3	4
enhancement	4	9	13
LogMeal	0	11	11
suggestion	0	1	1
bug	0	1	1
discussion	0	2	2
cognitive	1	1	2
confirmed documentation support	0	0	0



22 members of NESTORE were able to add issues to this GitLab. When writing this deliverable there were 24 issues still open (on 28th of February 2020) and 141 issues closed (see Figure 29). Some issues were still open because the dependencies among technical partners were high and it took time to understand the idiosyncrasy of each issue. Open issues covered multiple topics: UI changes, translations, data transfer, etc.

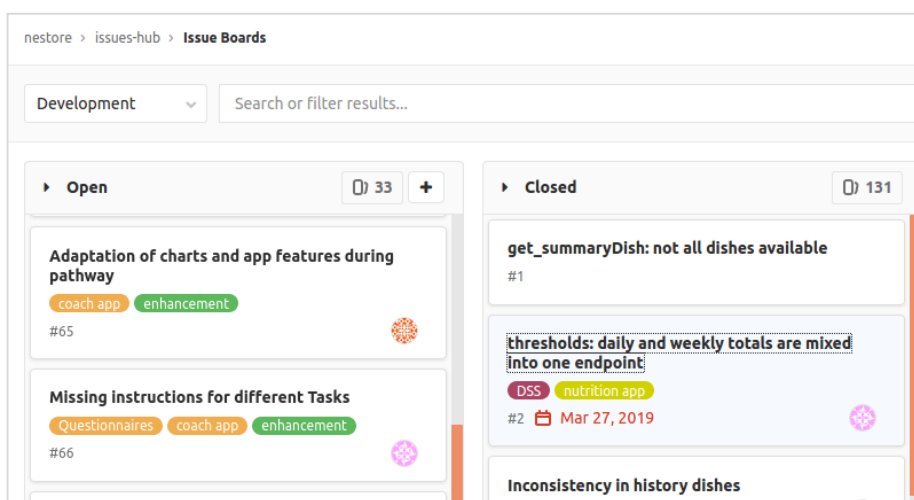


Figure 29 Open/Closed issues

The people that has access to GitLab has the rights to create an issue, update its status and close it once the appropriate solution has been found, implemented, and tested. A valuable functionality of GitLab is that you can exchange comments in every issue reported. In Figure 30 you can see a conversation that took place due to an issue reported.



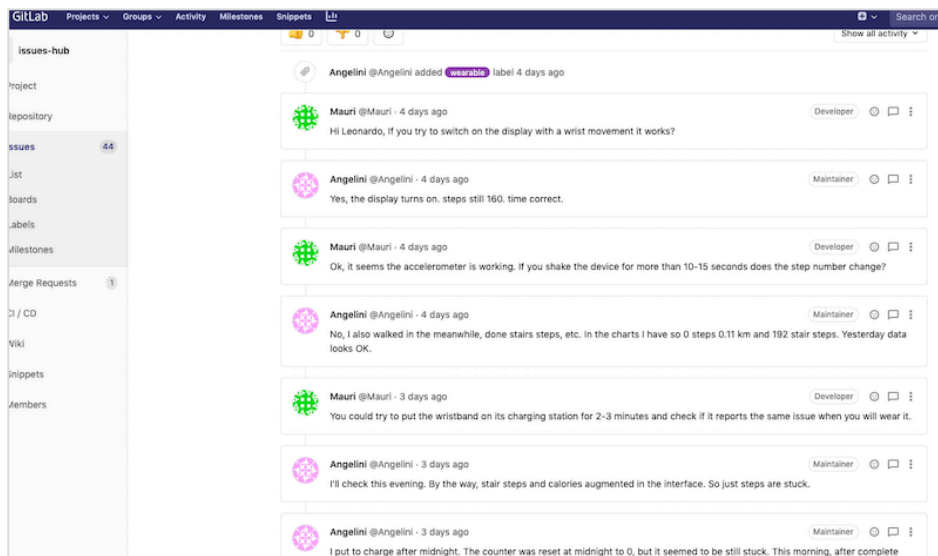


Figure 30. Comments on an issue inside GitLab.

8.4. Results

That many and diverse issues were detected thanks to the participation of many and diverse test users. In the next sections, we present the test users cohort as well as some quantitative indicators to outline the scope of the tests performed.

8.4.1. Participants description

In total, 37 people from the different institutions of NESTORE consortium tested different parts of the NESTORE system. This value corresponds to the number of profiles created in the my-nestore portal. From those 37 test users, 17 tested the application. In particular, 15 tested the 2 weeks phase, 2 the *extra* phase, and 9 the intervention phase. As explained in D4.4, the extra phase is triggered when not all the needed information to progress from the 2 weeks phase to the intervention phase has been gathered. During that time, the system pushed the user to send the required data to progress in the NESTORE journey.

The test users that worked with the NESTORE application used different devices that allowed for *mobile application testing*. Mobile application testing is a process by which an application software developed for handheld mobile devices is tested for its functionality, usability, and consistency. To do this kind of check, we



needed to check if the application was working well with the majorly used devices that had an Android version newer than 7.1.2, as set in the system requirements. The NESTORE applications were checked by 17 test users and all the Android versions newer than 7.1.2 were tested. The number of users that used each Android version can be read in Figure 31. Besides, 12 different screen resolutions were tested (Figure 32).

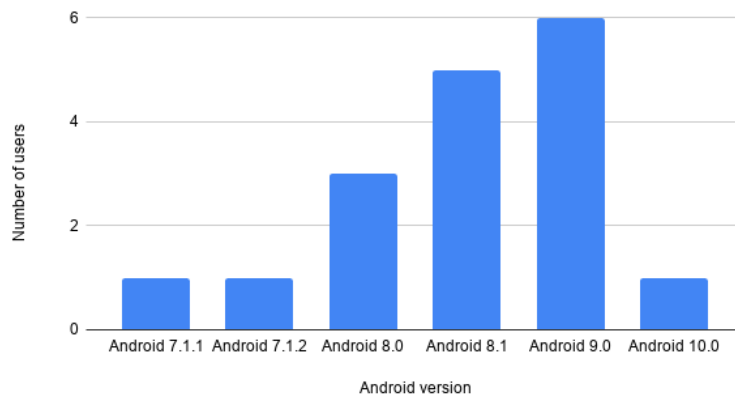


Figure 31. Distribution of users per Android version.

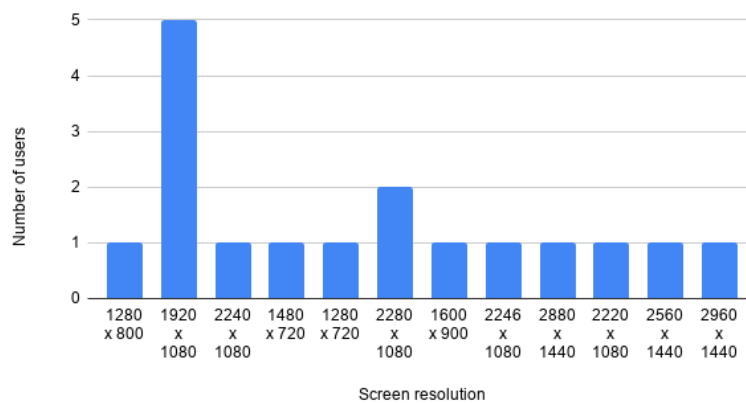


Figure 32. Distribution of users per screen resolution.

As explained in previous deliverables, the intervention phase starts just after the pathway selection. Figure 33 displays how many users per day tested the intervention phase. To sum up, 9 users tested for some time the intervention phase and 5 tested the system in the intervention phase for more than 3 weeks.



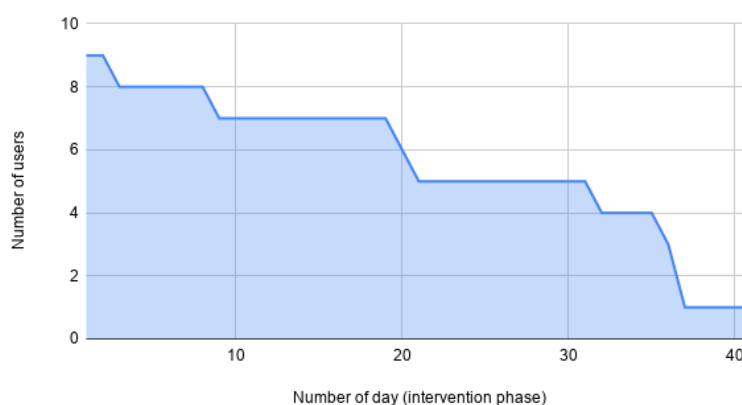


Figure 33. Number of test-users per day during the intervention phase.

8.4.2. General Indicators

During the testing period, all relevant pathways were chosen (see **Error! Reference source not found.** for details). The pathways that were not explicitly tested were NUT_INC_MM, NUT_INC_BW, NUT_DEC_BW, and PHY_RET_ST. All the nutritional pathways behave exactly the same and follow the same workflows. Hence, there was no need to test all of them. With regard to the PHY_RET_ST, the user journey is comparable to the one followed by the PHY_RET_AD. Therefore, its test was also not required.

Table 6. Distribution of pathways chosen during the intervention phase.

Domain	Pathway	Number of test users
Nutrition	NUT_ACH_HD	9
Cognitive	COG_IMP_ME	7
	COG_IMP_MS	1
	COG_IMP_TS	1
Social	SOC_IMP_SA	6



	SOC_IMP_SI	3
Physical activity	PHY_IMP_AF	4
	PHY_IMP_ST	3
	PHY_RET_AF	2

The coaching given for that time period is summarized by four indicators calculated during the testing phase. These results are shown in Table 7.

Table 7. Summary of the indicators tracked during the testing phase.

Indicator	Frequency
Number of structured activities sent	432
Number of unstructured activities sent	611
Cognitive games played	415
Number of photos sent to LogMeal	457

8.5. Detected problems and changes

The impact of the issues encountered can also be measured by the improvements developed during the testing phase in the eCoach app. On 18th of December 2019 the version 0.2.32 was in place. And two months later, on 18th of February 2020, the version 0.2.49 is in place.

8.5.1. Required changes on documentation



Following the report, the four issues arisen during the testing related to the documentation used to do the installation, it was modified the documentation as follows:

- With respect to the installation manual_4 v1.2, we have removed the firmware upgrade explanation in order to avoid hardware freezing. All the sensors have received the firmware upgrade and they don't require further updates.
- A technical troubleshooting manual has been created to support pilots in identifying and fixing hardware problems in the tangible coach:
<https://docs.google.com/document/d/1F6T3R8ClIT37LB285HcKzMF7eG4b5bUOye4EVrIAsDU/>
- A user-friendly manual has been also implemented to support the daily use of the tangible coach. It includes typical questions the user can ask, as well as some basic troubleshooting.
<https://nestore-coach.eu/documents/20182/26846/Tangible+coach+manual-+daily+tips.docx/6a465609-6ee3-43ac-9124-27480e281aa4?version=1.0&download=true>

8.5.2. Adjustments on hardware

The following issues were found when testing both the commercial and the NESTORE hardware.

- **Sleep sensor** – In practice, BCG sensors are placed under bed mattresses for sleep tracking, and hence several factors, e.g., mattress thickness, body movements, motion artifacts, bed-partners, etc. can deteriorate the signal. Some bed configurations showed a very thick mattress that led to deploy the sensor on the bed frame instead of the slats. No hardware modifications of the sensor were necessary.
- **Tangible coach** - A problem on the battery fixing of the tangible coach has been identified while testing. The PiJuice battery shield (commercial device bought for building the tangible) has a loose fixing of the battery, which may be detached during transportation or after falling. Many tangible coaches were received by testers with a detached battery, which hinder the coach correct functioning. After identifying the problem, all tangible coaches were opened and the battery was fixed using plastic strips. A drop fall test from 1-meter-high has been performed 3 times on a tangible coach. The tangible coach successfully passed the test after the strip fix

8.5.3. Adjustments on app design



Some issues related to the design of the applications were also solved during testing phase. Following we list the main ones:

1. Problem

The flow related to physical activities (structured and unstructured), sedentariness, coaching activity, weekly coaching planner, pairing with devices and platforms was unclear. Experts did not define all the parameters in a phase preceding the design.

Solution

After clarification meetings with all stakeholders, it was possible to redesign UX flow and redefine design elements iteratively.

2. Problem

As regards the recognition of food (combos, drinks, individual ingredients), the flow of food insertion has been focused on the use of the camera. The original input mode proved inadequate when the accuracy (initially attested at 98%) proved less precise.

Solution

Once the accuracy tests were done, it was possible to design flow more suitable for manual insertion, which became more critical during the project.

8.5.4. Adjustments on flows and implementation

Following, it was listed the main issues found during the internal testing on the interfaces between the Decision Support System(DSS) and the Coach app:

1. Problem

The DSS was trained with simulated data, so when it was tested in a real environment, some issues came up. The most important was related to the creation of the individuals' tags, which are used by the tagging system to propose personalized recommendations in form of Coaching Events. The function responsible of the creation of such tags was not working correctly when the profiles created on the DSS were not complete. This issue could happen, for example, when the user did not fill in the preferences on the Social Platform.

Solution:



The function responsible to create the tags for each profile was adapted, so that it could handle profiles with missing data.

2. Problem

When testers started the intervention phase and started to receive non-structured coaching events, we saw that they were not correctly visualized in the chatbot. After some tests, we saw that there was a misunderstanding about the type of identifiers that the DSS was sending in the MQTTs and the identifiers that the e-Coach was expecting.

Solution

The type of identifiers was designed and agreed and the interface was re-implemented and tested again.

3. Problem

When the user selects a pathway related to 'Aerobic Fitness', the DSS needs right after the selection, information about the preferences of number of days and frequency of the training sessions. This information was asked to the user too late in the e-coach interface, and it caused problems on the decision making of the DSS.

Solution

The e-coach developers were asked to redesign the workflow related to pathway selection, so that the endpoint of the DSS developed to get the information related to the 'Aerobic Fitness' preferences had to be called right after the pathway selection.

4. Problem

In some cases, the nutritional algorithms of LogMeal don't provide information about the food groups contained in the photo of the meal; the DSS provides a feedback to the user based on those food groups, so if they can't be recognized, the DSS provides a 'no_feedback' response. The e-coach wasn't dealing with 'no_feedback' response, so the visualization on the interface was not appropriate.

Solution

The e-coach developers treated the 'no_feedback' response, and no error is shown anymore to the user.

5. Problem



The structured activities suggested by the DSS and available through the weekly plan contains a title and a description. When the tests started and we saw the activities appearing for some users on their e-coach screens, we realized that some of the structured activities didn't have a title and a description, so users didn't know the meaning of such activity.

Solution:

Together with the designers and the pilot sites (who are doing the translation), we wrote the missing titles and translations.

Regarding the NESTORE social platform, during the internal testing phase there was identified the following problem:

1. Problem:

Some of the translations in different languages in all screens and messages of the social platform appeared weird because it was used Google Translate to translate simple sentences.

Solution:

During the test the partners prepared the correct translation for the Spanish, Dutch and Italian languages.

Regarding the sleep scale synchronization between the NESTORE cloud and the Withings Cloud, during the internal testing phase we faced the following problem:

1. Problem

The synchronization between the scale and the NESTORE cloud was not working.

Solution

The problem was related to an unannounced update of the Withings API. We fix the NESTORE Api by updating the synchronization mechanism between the NESTORE and the Withings Cloud.

Regarding the sleep sensors, during the testing phase we faced the following problem:

1. Problem

The total sleep time was not correspondent with sleep interval shown into the graphs.

Solution

The total sleep time counter shown into the app taken into account the sleep period sequence stored into the Zivacare endpoint "sleep/period". Some periods were not considered into the sum represented by



the total sleep time counter, so causing a misleading between the graph representation and the value shown.

2. Problem:

Partial visualization of sleep data into the NESTORE app. The graphs were correct but the total sleep time reported 0 hours and 0 minutes.

Solution:

The problem happened when a user slept after midnight. In the endpoint sleep on zivacare the filtering was done on the field "start_time" instead of the field "day". We fix this behaviour.

In the Nestore Coach app, different issues and new implementations were required during the testing phase. Following, we list the main ones:

1. Problem

Problem with structured physical activities and assessments that required the bracelet. In some cases the activities could not be started correctly by the NESTORE Connect. The implementation was not robust to errors and caused a lock in the interface, waiting for NESTORE Connect answer.

Solution:

HES-SO implemented a flow management measure integrating the user_task API, a solution discussed in the integration meeting of Barcelona (September 2019) but implemented in a slightly different way. The user_task API is used to store the state of any user flow that involve the setup of the bracelet, and monitors the progress by registering the user interactions with the app. We consider concluded only the activity that the user mark as finished, otherwise, in case of problems that may occur, they have to be rescheduled by the user or be proposed again by the coach.

2. Problem:

Problem when showing in the chatbot multiple DSS suggestions. When receiving multiple messages from DSS, some of them were lost and not correctly shown in the chatbot.

Solution:

A message queue has been implemented to manage correctly multiple notifications.



3. New implementation:

The adaptation of structured coaching activities based on the amount of daily unstructured activities done required the development of a new interface for adding unstructured activities.

4. New implementation:

The user might forget to take photos at every meal. In the Coach app and DSS we added the possibility to send a reminder at every meal (with the possibility to disable it from the interface).

The **Nestore Connect** app has gone through some internal, under the hood, redesign and some new feature has been added to work around issues discovered during the testing phase.

1. Problem:

The Wearable had severe stability issue, shutting down on its own even with full battery or stopping responding until manually shut down and turn on.

Solution:

Fixing the issues in the wearable firmware was too complex and time consuming, so it has been decided to define some new requirements for the communication between the Nestore Connect and the wearable, some examples:

- always wait the wearable advertising message and check its state before connecting or trying to perform operations on it
- introduce artificial delays between commands
- insert no-op windows after some specific commands (ex. prevent contacting the wearable for 45 seconds after a successful setup)
- avoid synchronization of any data while an activity like the 30 second test or a structured activity was in progress

The Nestore Connect has been modified to respect all these contracts of operations. The stability of the wearable greatly improved in our tests.

1. Problem:

The change introduced with the mandatory advertising message scan on the Wearable triggered another issue with the Android OS which requires a bit of background to be understood:



- the wearable wasn't designed to use Bluetooth Low Energy pairing, connection to it was performed directly using the know physical address of the device, the new requirement was to perform a Bluetooth Low Energy Scan before every connection;
- the BLE scan operation is usually meant to look for unknown Bluetooth Low Energy devices and it is a battery-expensive operation; for this reason the Android OS is restrictive in letting apps running in background perform too many BLE scans; the actual constraints aren't documented so they can't be clearly defined, but they can be summarized with A) apps aren't allowed to perform BLE scans in background for more than 30 seconds every 1 minutes and B) they aren't allowed to scan more than a set amount of times in 1 hour. Apps that are too aggressive with the Bluetooth scanning can be put into a blacklist by the OS with no way of knowing this happened: they just start to get no data from scans until the device is rebooted and any kind of Bluetooth communication fails;
- NESTORE Connect used to perform each single synchronization task as a single independent entity that retried until it succeeded to connect to the wearable and synchronize the data. For example, a job to obtain non-structured activities from 2 to 3 pm on Thursday was scheduled to retry until it succeeded to grab the data from the wearable. Several jobs were scheduled and kept retrying on their own accord, with the scan before connect change the app ended up being put in the Bluetooth blacklist.

Solution:

A complete rewrite of the synchronization mechanism was needed: the current version of the Nestore Connect performs the synchronization in batches once per hour and if the wearable is not reachable it waits the next hour to try again.

In this way, the need for BLE Scan is greatly reduce and being put into the blacklist becomes very unluckily.

2. Problem:

Due to time constraints the wearable does not retain the current time and some other setting across shut downs. This means that if the wearable shut down a new setup from the wearable connect is needed in order for the wearable to resume showing the current time and gathering data.

Internally, the wearable, store data in 4 different sectors, it rotates between them each day deleting the oldest one. When turned on it waits for a setup and right after the setup it positions itself on the first sector again and deletes it.

Due to this behavior we could lose data not yet gathered before the wearable turned off, and this could happen for an issue with the wearable or by accidents: user shutting it down by mistake or forgetting to charge it letting it down for no battery.



Solution:

A new recovery-wizard feature has been implemented.

The new wizard guides the user into placing the wearable close to the device, make sure it is turned on and proceed to synchronize all the pending data before finishing the process with a new setup.

The recovery procedure is used to also recover from other potentially problematic conditions:

- Bluetooth disabled on the device
- location services disabled on the device
- android permissions revoked from the user

The recovery procedure is triggered if any of the previous conditions is detected or if the wearable signal that it needs to be setup again. The recovery is also triggered if too much time without synchronization has pass (24 hours).

The trigger is an Android Notification visible to the user.

Additional improves:

The Nestore Connect already had a Developer Mode adding a Monitor Task section that allowed to monitor the background jobs state but it was a bit hard to read.

A revamped Monitor Task section was developed to make it easier for the pilot managers and other partners the monitoring and debug the background processes being executed.

8.6.Tracking the evolution of the testing phase

A *Python* script was also developed to keep track of important indicators gathered throughout the testing phase. The script was done in a generalist manner, so that the same procedure and code will be used to track the evolution of some KPIs during the pilot.

Here we report the 5 most important indicators registered using this script, depicted in form of graphs in Figure 34, Figure 35 and Figure 36, and corresponding to the following indicators Figure 34.:

- Number of photos taken



- Physical activity tests performed
- Number of structured activities scheduled
- Physical activity structured activities performed
- Pathway selected

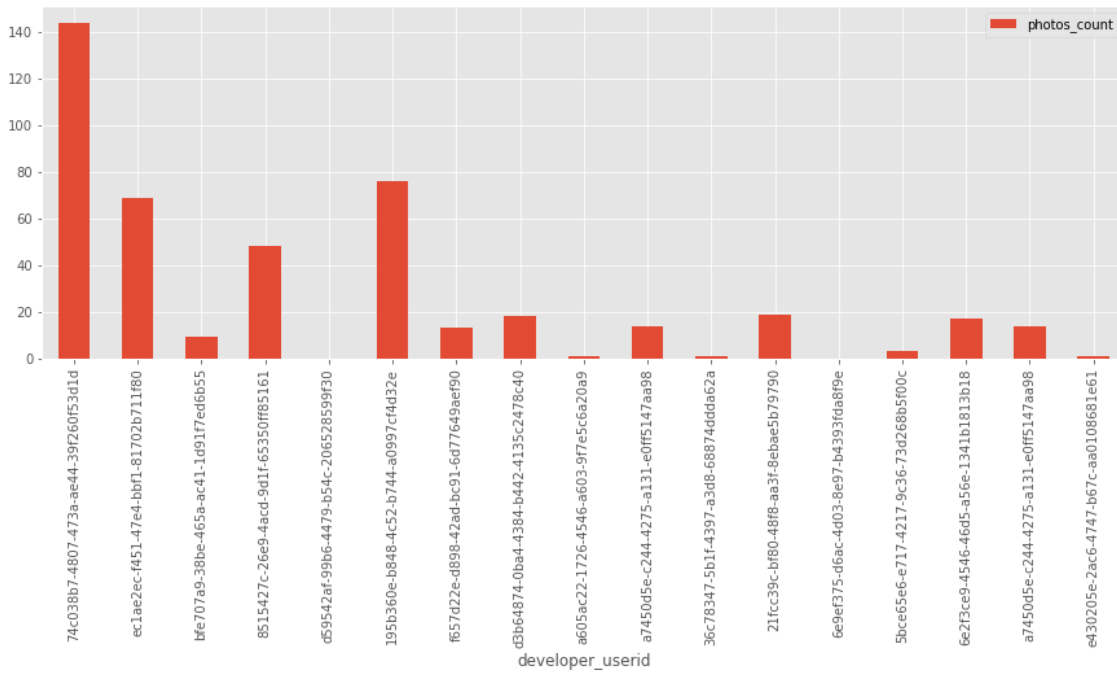


Figure 34. Number of dish photos sent to the NESTORE platform by every testing user.



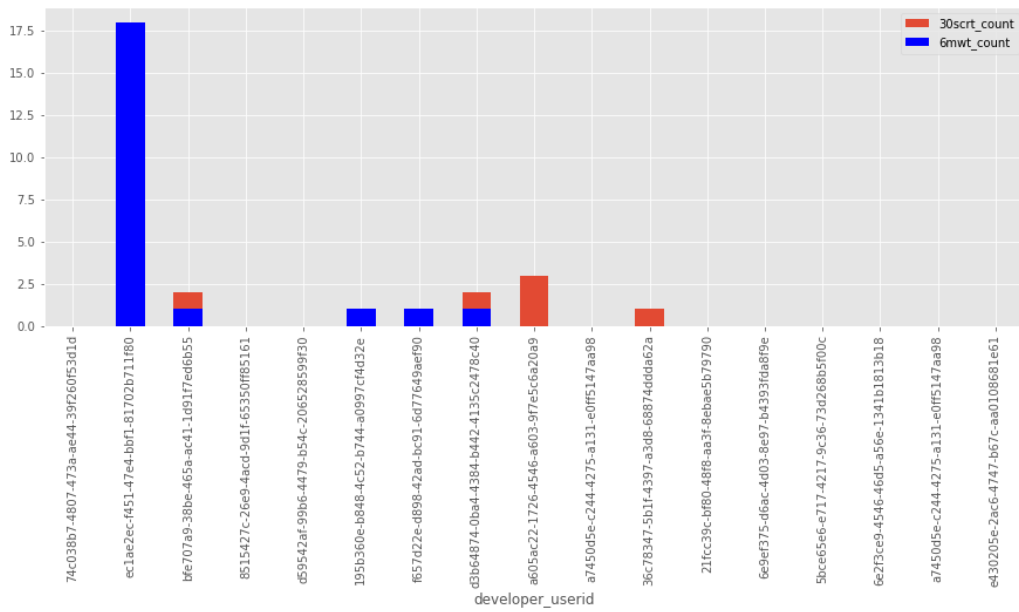


Figure 35. Number of physical activity tests (30 seconds chair rise test and 6 minutes walking test) performed by every testing user.

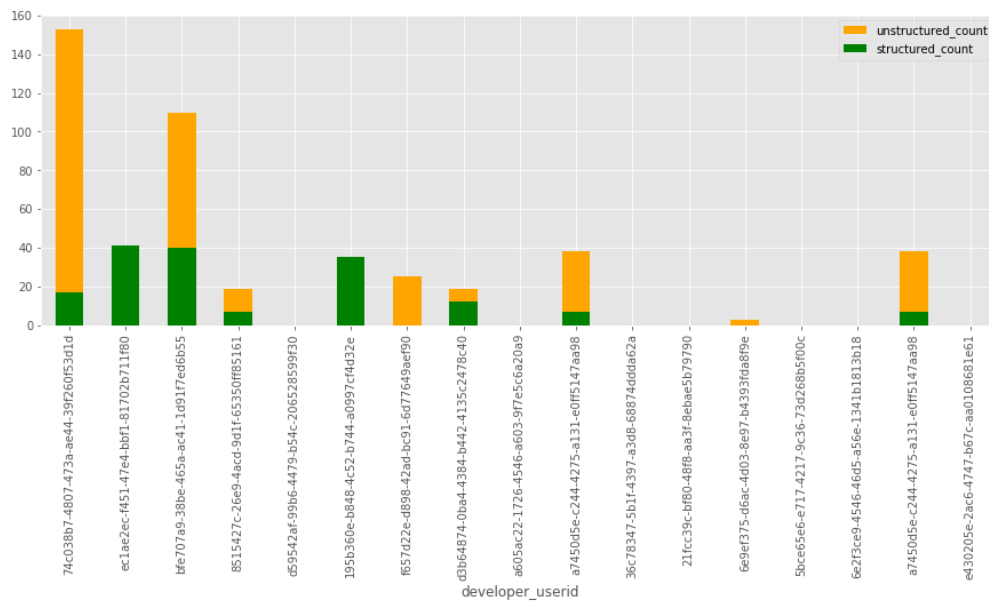


Figure 36. Number of structured activities and unstructured activities scheduled and received by every testing user.



Additional improvements carried out during lockdown

During lockdown, several tests and improvements were carried out. The e-coach app passed from the release of 0.2.49 in February 18th to 0.2.67 in July 31st. This is a non-exhaustive list of the improvements that were carried out and tested during this period.

- Added environmental beacons information page in the app (New feature, added later as it was an optional requirement)
- Added manual search option for adding food without taking photo (added as a result of the problems encountered during testing)
- Simplified management for modifying food entries once the photo is uploaded (any combination of foods can now be added)
- We introduced the possibility to schedule at once a series of the coaching activities when receiving the weekly plan. This included the reduction of the number of possible repetitions of the event to match the number of days left for scheduling the activity.
- The management of the post-test assessment was introduced.
- Added some missing introductory texts to questionnaires and tests
- Added some missing translations (variables)
- Improved the management of physical structured activities, in particular for starting and stopping the activities. Added missing instructions on smart bracelet behaviour.
- Improved the management of structured activities in the cognitive domain as well as the chart
- Added backup of baseline and post-test data, in case of data loss in the API.
- Added post-test tests and questionnaires

Additional work was carried out for ensuring proper functioning of the tangible coaches. Tangible Coaches were all unmounted and fixed with the strip in late February, but were remounted and shipped on the run to the pilot sites for ensuring the start of the pilot at the beginning of March. To ensure proper functioning, all tangible coaches were all carefully retested. We actually found out that many of them were remounted incorrectly and not working, and needed to be unmounted and remounted correctly. In the process, 2 PiJuice hats and 1 Matrix Voice were found defective and were substituted.



8.7. Conclusions

The set of integrated tests carried out lead to many improvements in the whole NESTORE system.

Figure 37 depicts the status of each of the NESTORE components on the last day of the last integration meeting (20th – 21st January 2020). As you can see, we analyzed the behavior of each component of the monitoring system in each of the aspects they have influence on: installation, data gathering, saving data, processing data, visualizing data, and, for the bracelet and the tangible, battery. Most of these components performed satisfactorily in each of the aforesaid aspects. The components that presented an unsatisfactory performance were tackled separately and a mitigation plan was designed for each weak aspect of each component. For instance, a troubleshooting document has been created to help installers in the presence of difficulties when installing the tangible (link to document:

<https://docs.google.com/document/d/1F6T3R8Clit37LB285HcKzMF7eG4b5bUOye4EVrIAsDU/edit?usp=sharing>).

	Installation	Data gathering	Saving data	Processing data	Visualizing data	Other
Scale	✓	✓	✓	✓	✓	
Bracelet	✓	✓	✓	✓	✓	
Sleep sensor	✓	✓	✓	✓	✓	
Tangible	✓	✓	✓	✓	✓	
Social B	✓	✓	✓	✓	✓	
Environment	✓	✓	✓	✓	✓	
Wearable	✓	✓	✓	✓	✓	
APP	✓	✓	✓	✓	✓	

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	DSS	e-Coach	NEOS
Bracelet	✓	✓	✓
Tangible	✓	✓	✓
Sleep sensor	✓	✓	✓
Wearable	✓	✓	✓
Environment	✓	✓	✓
APP	✓	✓	✓

NEOS
 Troubleshooting in NEOS context

System Ready the 27.01.20
 x test scores and training adherence

Figure 37. Snapshot of the work done during the last integration meeting (20th -21st January 2020).



9. Annexes

9.1. Annex 1 - Wearable Device Tests

The wearable device designed and developed by Flextronics in the context of the NESTORE project will be tested in order to assess the validity of the measurements provided. In particular, the following variables were investigated:

- 1) number of squats performed during the Modified 30 sec Chair Rise Test;
- 2) Time spent in each HR intensity target during structured activity on a treadmill;
- 3) number of steps during walking/running in free living;
- 4) number of stairs climbed.

Measurements obtained using “gold standard devices” will be used as benchmarks.

The wearable device was tested in controlled conditions in a population of 5/6 healthy adults (Age range 20-40). The activities proposed in this document are included and reported in the WP7 - Task 7.4.

Preliminary Technical Steps

Account Creation

In order to use the Nestore Connect a new user account should be created at the following link:

<https://dev.nestore-coach.eu/>

Complete the User profile in all its fields in order to use correctly the Nestore Connect.



Nestore Connect Download

The Nestore Connect is available on the Google Play service and it can be downloaded at the following link:

<https://play.google.com/apps/testing/com.neosperience.nestoreagent>

The Nestore Connect is running just on Android systems. Use your personal credential to login. The login will allow the app to retrieve the User Profile and a List of User Devices from Nestore Cloud. This information will be used to setup the wearable.

Just some selected gmail accounts can have access to the download.

Configuration of the wearable

Each device must be associated to the user, using its MAC address as unique ID, at the following link:

<https://developer.nestore-coach.eu/>

The device should be inserted and linked to the user in the **Dashboard/NestoreDev/Robofuse/Asset** list section.

Data Retrieval

All the data that were previously synchronized using the Nestore Connect can be collected at the following link using the appropriate GET API:

<https://datastore.robofuse.com/>

Experimental Set up

Modified 30 sec Chair Rise Test

Where: ITB labs

Protocol: The participant were seated in the middle of the chair, back straight; feet approximately shoulder width apart and placed on the floor at an angle slightly back from the knees, with one foot slightly in front of the other to help maintain balance. Arms were crossed at the wrists and held against the chest. The participant were



encouraged to complete as many full stands as possible within 30 seconds. The participant had to fully sit between each stand.

A tester counted the completion of each correct stand.

Devices: NESTORE wearable device (wristband);

Time spent in each exercise intensity HR target in lab

Where: ITB labs

Protocol: The participant performed a session of structured activity on a treadmill. A plan including light (7 min), moderate (11 min) and vigorous activity (12 min) was proposed to the subjects. Different speeds were selected in order to allow the subjects to be compliant with the prescribed exercise intensity. Each test lasted 30 minutes. The exercise intensity was assessed by HR measurements. The parameters provided by the NESTORE wristband were compared to those obtained using a commercial chestband.

Devices: NESTORE wearable device (wristband); Garmin Fenix 3/Polar A300 (chestband);

Number of steps in free living

Where: ITB campus

Protocol: The participant performed two constant speed exercises in an outdoor track. Different speeds were selected in order to collect data both during walking (<7km/h) and running (>8km/h). Each test lasted 5 minutes. During the test, the number of steps provided by the NESTORE wristband will be compared to those obtained using commercial products.

Devices: NESTORE wearable device (wristband); Garmin Fenix 3 (wristband);

Stair Climbing

Where: ITB building; stairs.



Protocol: The participant were instructed to climb 5 floors (130 steps) on foot and subsequently to go down to the starting floor. During the test, the parameters provided by the NESTORE wristband were compared to the actual value.

Devices: NESTORE wearable device (wristband);

The tests were carried out on September 2019. Data were analysed using standard statistical methods (descriptive and inferential statistics) in order to assess the reliability of the measurements obtained with the NESTORE device.

Results

Modified 30 sec Chair Rise Test

The results described below, regarding the 30 sec Chair Rise Test (30SCRT) validation, were obtained testing the NESTORE wearable device embedding the new **firmware version 1.5.6**.

The evaluation of the 30SCRT was performed considering a movement compliant to the NESTORE user age (<21 squats within 30 seconds), also considering that the threshold to differentiate between people needing improvement and people with sufficient strength performance is 10-12 squats. As reported in table 8 and in Figure 1, the number of squats performed during 30SCRT, assessed using NESTORE device, is slightly underestimated with respect to the real value. The error is on average less than 2%. It is worth noticing that the most frequent event affecting the accuracy is that the wearable is not able to count the last movement.



Table 8. 30SCRT Data.

				NESTORE	Counted	Err %
<i>Subject</i>	<i>Age</i>	<i>Weight (kg)</i>	<i>Height (cm)</i>	<i>Trail 1</i>	<i>Trial 1</i>	<i>Trial 1</i>
MM	25	78	183	15	16	6.25%
MC	29	66	175	16	16	0.00%
ES	34	62	165	18	18	0.00%
RG	57	62	164	20	21	4.76%
DC	24	70	182	16	16	0.00%
AM	35	73	173	17	17	0.00%
Mean	34	68.5	173.7	17.00	17.33	1.84%
Dev Std	12.13	6.38	8.09	1.79	1.97	2.88%

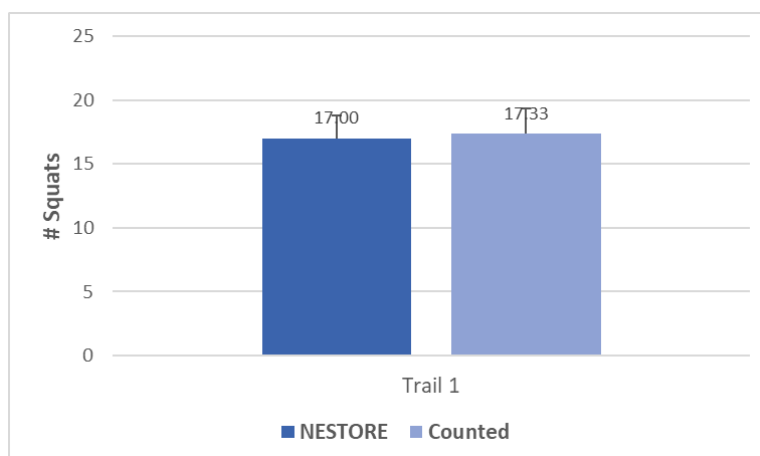


Figure 38. Average squats measured during 30SCRT compared to the actual squats.

The evaluation of the 30SCRT was repeated considering a faster movement (>21 squats within 30 seconds). In this case, as shown in table 9 and Figure 39, the underestimation of the squats is drastically increased with an error of about 40%. Since the NESTORE users are all aged over 65, it is very unlikely that this second scenario, with faster movements, could happen during the real use of the system.



Table 9. 30SCRT Data during the execution of a faster movement.

				NESTORE	Counted	Err %
Subject	Age	Weight (kg)	Height (cm)	Trial 1	Trial 1	Trial 1
AM	35	73	173	14	29	51.72%
AM	35	73	173	13	26	50.00%
ES	34	62	165	13	23	43.48%
MC	29	66	175	21	24	12.50%
DC	24	70	182	14	23	39.13%
AM	35	73	173	13	26	50.00%
Mean	32	69.5	173.5	14.67	25.17	41.14%
Dev Std	4.56	4.59	5.43	3.14	2.32	14.82%

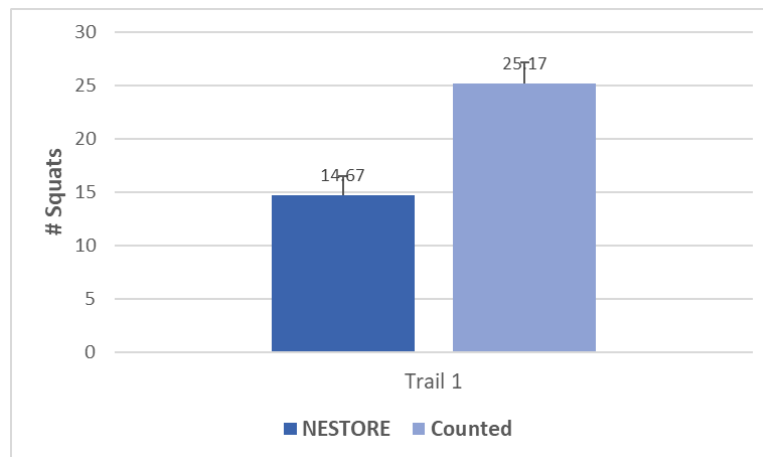


Figure 39. Average squats measured during 30SCRT during the execution of a faster movement compared to the actual squats.



Time range in each exercise intensity HR target in lab

The results discussed in this paragraph refer to the **firmware version 1.5.9**. As reported in table 10 and Figure 40, NESTORE system estimates the global activity with an average global error, thus considering the entire duration of the activity, of 8.95% (max 13.33%; min 1.90%).

Table 10. Structured Activity Data.

Subject	Age	Weight (kg)	Height (cm)	NESTORE/Wristband			Garmin-Polar Chestband			Global Error %
				Light (s)	Moderate (s)	Vigorous (s)	Light (s)	Moderate (s)	Vigorous (s)	
AP	25	66	171	128	408	724	133	415	712	1.90%
LR	29	66	175	128	400	732	98	484	678	13.33%
GB	24	70	174	185	369	706	180	409	671	6.35%
SP	38	67	173	158	509	593	92	501	667	11.75%
RM	31	78	181	132	503	625	116	447	697	11.43%
Mean	29	69.4	174.8	146.2	437.8	676.0	123.8	451.2	685.0	8.95%
Dev Std	5.59	5.08	3.77	25.04	63.97	62.91	35.29	40.82	18.99	4.73%

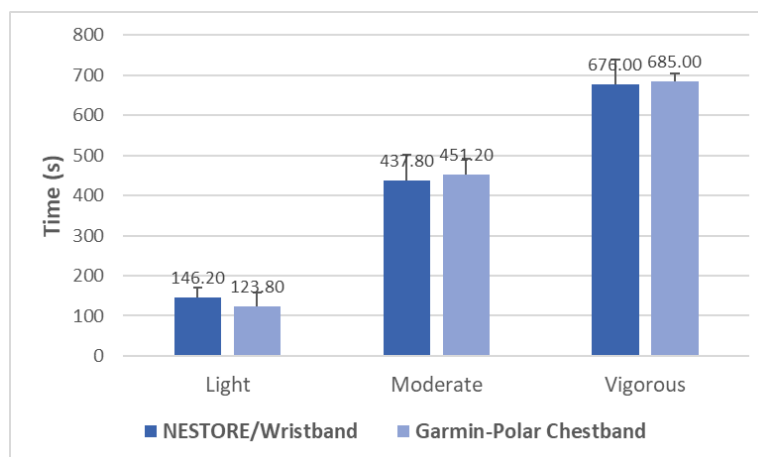


Figure 40. Average time spent in each target intensity compared. Comparison between NESTORE and Garmin-Polar chestband.

It is worth noticing that the error does not heavily affect the final score that the NESTORE system attributes to the whole session. In fact, if the NESTORE scores are considered, the differences between NESTORE wristband and the commercial chestbands are on average less than 5%, as reported in table 11 and Figure 41. This aspect



is relevant since the aerobic score is a crucial parameter both for providing user feedback and for adapting the coaching activities.

Table 11. Aerobic Scores calculated using NESTORE and commercial devices.

Subject	Score Chestband	Score NESTORE	Error %	Expected Score
AP	6.35	6.40	0.76%	6.3
LR	6.30	6.43	2.06%	
GB	6.14	6.25	1.77%	
SP	6.27	5.91	-5.69%	
RM	6.33	6.06	-4.21%	
Mean	6.28	6.21	0.03	
Dev Std	0.08	0.22	0.04	

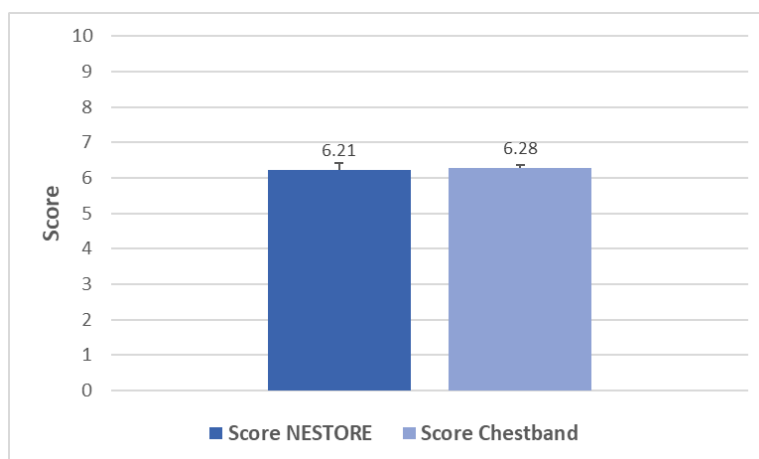


Figure 41. Average aerobic scores calculated using NESTORE and commercial devices.

Number of steps in free living



The results described in this paragraph were obtained testing the NESTORE wearable device embedding the **firmware version 1.4.3**. Regarding the number of steps, the NESTORE system slightly underestimates, with respect to the Garmin Fenix 3, both the steps obtained during walking, with an error of about 6%, and those obtained during running, with an error of about 3%. Data are listed in table 12 and shown in Figure 42.

Table 12. Steps during walking and running.

Subject	Age	Weight (kg)	Height (cm)	NESTORE		Garmin Fenix 3		Err %	
				Walking	Running	Walking	Running	Walking	Running
AP	25	66	171	517		603		14.26%	
LR	29	66	175	519	796	500	798	3.80%	0.25%
GM	25	83	191	503	823	480	818	4.79%	0.61%
AM	35	73	173	574		570		0.70%	
GB	24	71	175	449	811	418	809	7.42%	0.25%
ML	26	90	182		719		813		11.56%
Mean	27	74.8	177.8	512.40	787.25	514.20	809.50	6.19%	3.17%
Dev Std	4.13	9.70	7.44	44.63	46.82	73.53	8.50	5.11%	5.60%

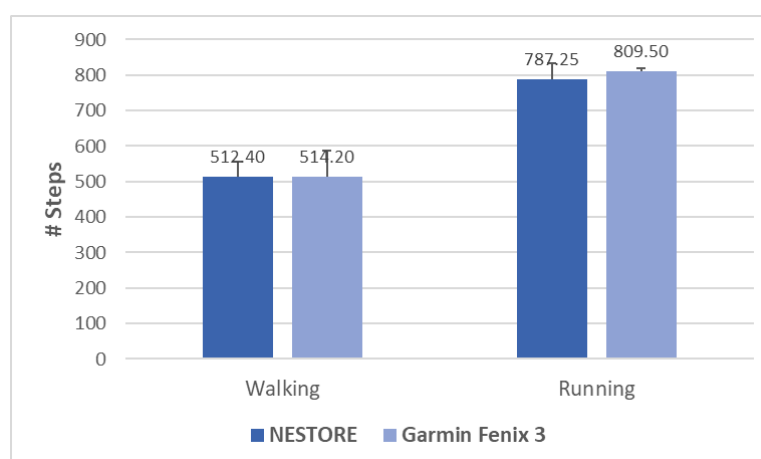


Figure 42. Average steps during walking and running. Comparison between NESTORE and Garmin Fenix 3.

Stair Climbing



The results described below, regarding the stair climbing validation, were obtained testing the NESTORE wearable device embedding the new **firmware version 1.5.6**.

The number of stair steps was measured going upstairs and downstairs by means of the NESTORE device. The error is about 9% for the upstairs and 10% for the downstairs direction.

Data are reported in table 13 and Figure 43.

Table 13. Stairs climbing Data.

Subject	Age	Weight (kg)	Height (cm)	NESTORE		Steps	Err %	
				Upstairs	Downstairs	5 floors	Up	Down
DC	24	70	182	140	138	130	9.68%	10.97%
LR	29	66	175	137	139	130	5.38%	6.92%
ES	34	62	165	109	133	130	16.15%	2.31%
RM	31	78	181	126	118	130	3.08%	9.23%
AM	35	73	173	124	145	130	4.62%	11.54%
SP	38	67	173	112	108	130	13.85%	16.92%
Mean	32	69.3	174.8	124.67	130.17	130.00	8.79%	9.65%
Dev Std	4.96	5.65	6.21	12.61	14.19	0.00	5.33%	4.89%



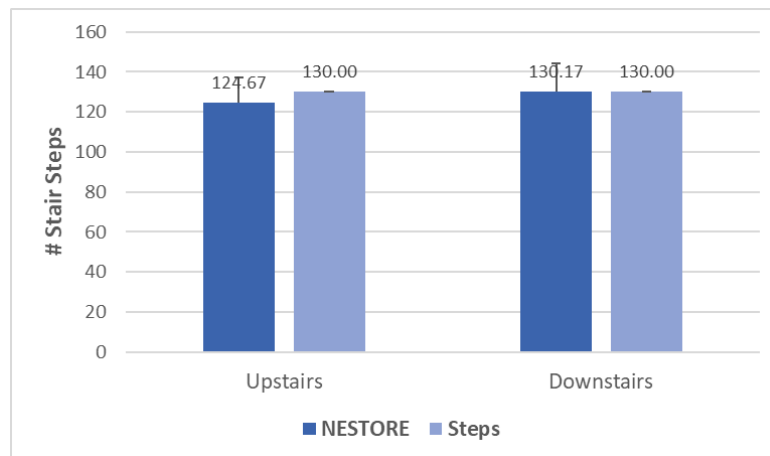


Figure 43. Average stairs steps calculated by NESTORE and compared with the actual number of steps.

9.2. Annex 2 - Software/Firmware Ad-Hoc Test Report

Purpose and Scope

Purpose of this document is to summarize the results of the SW/FW Ad-Hoc testing activities performed by SW QE on the Nestore wristband.

The test cases have been executed on the FW version 1.5.4, 1.5.6, 1.5.7 and 1.5.9.

Terminology and Abbreviation

ACRONYM / ABBREVIATION	DESCRIPTION
App	Mobile Application
BLE	Bluetooth Low energy
Flex	Flextronics Design S.r.l. (Flex Design Milan)
FW	Firmware
N/A	Not Applicable



ACRONYM / ABBREVIATION	DESCRIPTION
QE	Quality Engineer
SVN	SubVersioN (revision control system tool)
SW	Software
TC	Test Case

Test Environment

The identified test environment is described as follow:

- 6 wristbands,
- 5 environmental beacons,
- 5 social beacons,
- Dock in station used to charge the battery of the wristbands,
- The NestoreLibApp mobile App used to perform wristband connection and to upload the logs (Ver. 1.7.0)
- Android smartphone (Android 8.0.0)
- NRF Connect to perform connection evaluation 8 (Ver.4.21.0)

NOTE: the wristbands used have been specified in each test case description.

Test Object

Device Under Test

The following devices have been used during the Ad-Hoc Test execution:

DEVICE		NOTES
TYPE	MAC ADDRESS	
Wristband1	C4:64:E3:F0:B5:48	FW Ver. 1.5.4
Wristband2	C4:64:E3:F0:B4:7B	FW Ver. 1.5.4
Wristband3	C4:64:E3:F0:B5:23	FW Ver. 1.5.4
Wristband4	C4:64:E3:F0:B5:78	FW Ver. 1.5.6
Wristband5	C4:64:E3:F0:B6:91	FW Ver. 1.5.6



DEVICE		NOTES
TYPE	MAC ADDRESS	
Wristband6	C4:64:E3:F0:B5:3A	FW Ver. 1.5.7
Environmental beacons	C3:1C:3E:21:49:12	None.
Environmental beacons	E6:6D:9F:70:A5:1D	None.
Environmental beacons	CF:D7:88:84:70:40	None.
Environmental beacons	D7:6F:1D:BE:61:85	None.
Environmental beacons	F6:15:6B:BC:73:E5	None.
Social beacons	C7:66:58:AE:E0:75	None.
Social beacons	F5:1A:6A:6A:C7:8E	None.
Social beacons	D9:42:7F:55:1A:3A	None.
Social beacons	CE:A7:43:85:F6:BD	None.
Social beacons	CF:C1:99:FC:D7:69	None.

SW/FW Ad-Hoc Test Report

Test Case Results

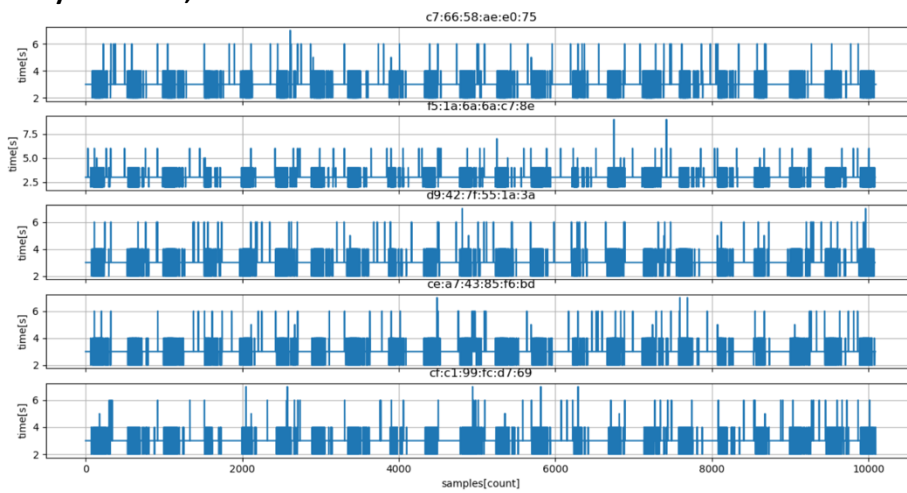
TEST CASE			
ID	DESCRIPTION	RESULT	BUG DESCRIPTION
TC_1	<p>Wristband – First power on</p> <p>Wristbands used: wristband1, wristband2, wristband3, wristband4, wristband5, wristband6.</p> <p>Perform the first wristband power on. Check the wristband allows to do no actions without setting the current data/time. Check the screen of the wristband, it is displaying the icon of the smartphone to start. Battery charge animation is not displayed in this condition.</p>	Pass	N/A
TC_2	<p>Wristband – First mobile App connection</p> <p>Wristbands used: wristband1, wristband2, wristband3, wristband4, wristband5, wristband6.</p> <p>Perform the first wristband power on. Connect the wristband to the App without writing the mac address. Check the connection is not established. In the App, insert the mac address of the wristband, save the changes and then kill the</p>	Pass	N/A



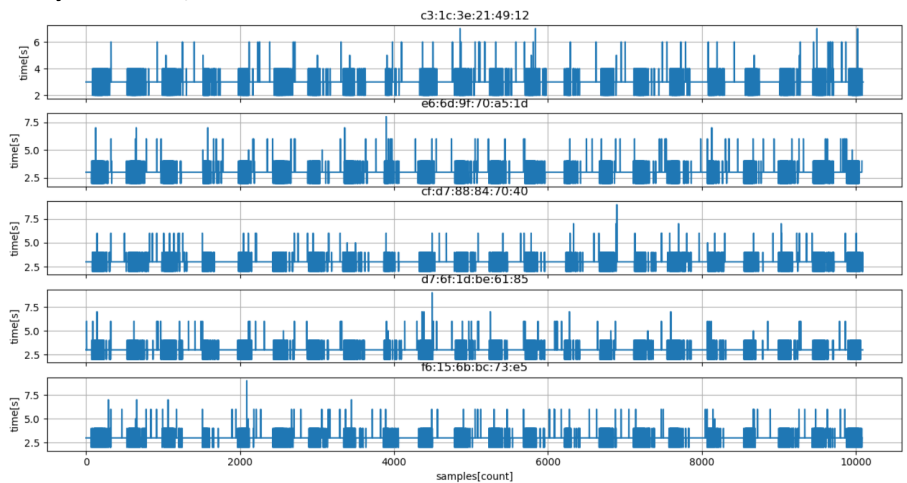
	app. Connect the wristband, check the connection is established. In the App, set the wrong data/time and check the wrong time on the screen. In the App, set the current data/time and the fill all the fields related to the User Characteristics, then save the changes. Check the current time is displayed on the screen of the wristband.		
TC_3	<p>Beacons – Wristband connection</p> <p>Connect the wristband to the App, then write the MAC Address of the 10 beacons available (Environmental and Social), then save the settings. Read the Mac addresses of Environmental and Social beacons, check they are the same added previously.</p>	Pass	N/A
TC_4	<p>Wristband and Beacons – BLE advertising time</p> <p>Wristbands used: wristband1, wristband2, wristband3, wristband4, wristband5, wristband6.</p> <p>Using the NRF Connect mobile App, check the beacons are available for connections with BLE advertising interval of about 350 ms and the wristband is available for connection with BLE advertising interval of about 300 ms.</p>	Pass	N/A
TC_5	<p>Beacons data acquisition – Logs upload</p> <p>Wristbands used: wristband6.</p> <p>Place all the 10 beacons in the working range of the wristband. Wait for about 8 seconds, then connect the wristband to the App and upload the logs of the environmental and social beacons. Check the wristband received data from each beacons each 3 seconds (± 1 second). The test has been performed in daily condition simulating the subject is at home.</p> <p>In the figures below, it is displayed the advertising interval in which the beacons sent data to the wristband. The advertising interval is about 3 seconds (± 1 second), on average.</p>	Pass	N/A



Daily condition, social beacons



Daily condition, environmental beacons



The table below reports the percentage of data lost due to advertising intervals greater than 3 seconds (+1 second). The values refer to the data lost from all environmental beacons and from all the social beacons involved in this test.

Beacons		Acquisition time
Environmental	Social	
0.77%	0.76%	8 h

TC_6	Beacons environmental – Temperature and humidity data Wristbands used: wristband6.	Pass	N/A
------	--	------	-----



	Place all the 10 beacons in the working range of the wristband. Wait for about 8 hours, then connect the wristband to the App and upload the logs of the environmental and social beacons. The consecutive temperature values are different less than 2.58% (± 1 degree). The consecutive humidity values are different less than 1.82% (± 1 unit).																																																																													
TC_7	<p>Daily activities – Sedentariness period</p> <p>Wristbands used: wristband4.</p> <p>Perform the test wearing the wristband. The user is not active for more than 11 minutes. Then the user perform movements for about minutes. Then the user is not active for 61 minutes at least. Check the alert icon on the screen of the wristband, then the user is active, check the message of encouraging displayed on the screen of the wristband. Then the user is not active for 61 minutes at least. Upload the logs for the Non Structured and Sedentariness activities.</p> <p>As reported in the tables below, in the sedentariness logs there are 3 entries, one for sedentariness period. In the Non Structured log, check the time duration in the LowActivity column, shall match with the one reported in the sedentariness log, taking into account the active time interval.</p> <table border="1"> <thead> <tr> <th colspan="11">Non Structured Log</th> </tr> <tr> <th>day</th> <th>startHour</th> <th>stopHour</th> <th>lowActivity</th> <th>walking</th> <th>running</th> <th>steps</th> <th>distance</th> <th>stairsUp</th> <th>stairsDown</th> <th>energyConsumption</th> </tr> </thead> <tbody> <tr> <td>7/10/2019</td> <td>08:00:00+01:00</td> <td>08:59:00+01:00</td> <td>13</td> <td>1</td> <td>2</td> <td>526</td> <td>352</td> <td>0</td> <td>0</td> <td>2</td> </tr> <tr> <td>7/10/2019</td> <td>09:00:00+01:00</td> <td>09:59:00+01:00</td> <td>60</td> <td>0</td> <td>0</td> <td>15</td> <td>18</td> <td>0</td> <td>0</td> <td>562</td> </tr> <tr> <td>7/10/2019</td> <td>10:00:00+01:00</td> <td>10:59:00+01:00</td> <td>57</td> <td>0</td> <td>1</td> <td>288</td> <td>215</td> <td>0</td> <td>0</td> <td>75</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th colspan="4">Sedentariness Log</th> </tr> <tr> <th>day</th> <th>startHour</th> <th>stopHour</th> <th>period</th> </tr> </thead> <tbody> <tr> <td>7/10/2019</td> <td>08:43:46+01:00</td> <td>08:56:15+01:00</td> <td>1</td> </tr> <tr> <td>7/10/2019</td> <td>08:58:51+01:00</td> <td>10:02:31+01:00</td> <td>2</td> </tr> <tr> <td>7/10/2019</td> <td>10:04:05+01:00</td> <td>11:23:52+01:00</td> <td>3</td> </tr> </tbody> </table>	Non Structured Log											day	startHour	stopHour	lowActivity	walking	running	steps	distance	stairsUp	stairsDown	energyConsumption	7/10/2019	08:00:00+01:00	08:59:00+01:00	13	1	2	526	352	0	0	2	7/10/2019	09:00:00+01:00	09:59:00+01:00	60	0	0	15	18	0	0	562	7/10/2019	10:00:00+01:00	10:59:00+01:00	57	0	1	288	215	0	0	75	Sedentariness Log				day	startHour	stopHour	period	7/10/2019	08:43:46+01:00	08:56:15+01:00	1	7/10/2019	08:58:51+01:00	10:02:31+01:00	2	7/10/2019	10:04:05+01:00	11:23:52+01:00	3	Pass	N/A
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TC_8	<p>Evaluation test 30 SCRT – Heart Rate evaluation</p> <p>Subject involved: S1 (Male), S2 (Female).</p> <p>Wristbands: wristband1, wristband5 for S2; wristband3 wristband4 for S1.</p> <p>The subjects performed the test wearing two wristbands, one per wrist. During same sessions, the wristbands are kept connected to the App. No differences in performances have been reported between wristband connected to the App or not, during the test. The table below resumes the data acquired:</p>	Pass	N/A																																																																											



30SCRT	Trial	wristbands connected to the App	Squat Performed	Squat recorded by Nestore		Err %		
Male				wristband 4	wristband 3	wristband 4	wristband 3	
	1	No	12	11	11	8.333	8.333	
	2	No	14	13	13	7.143	7.143	
	3	No	14	14	14	0.000	0.000	
	4	yes	14	13	13	7.143	7.143	
	5	yes	14	14	13	0.000	7.143	
				Mean %		4.524	5.952	
				Dev Std %		4.1581546	3.3671751	
30SCRT	Trial	wristbands connected to the App	Squat Performed	Squat recorded by Nestore		Err %		
Female				wristband 5	wristband 1	wristband 5	wristband 1	
	1	No	19	18	19	5.263	0.000	
	2	No	17	17	17	0.000	0.000	
	3	No	16	16	16	0.000	0.000	
	4	yes	14	14	14	0.000	0.000	
	5	yes	13	11	10	15.385	23.077	
				Mean %		4.130	4.615	
				Dev Std %		6.6918068	10.320314	
TC_9	Evaluation test 6MWT – Steps evaluation during walking Subject involved: S1 (Male), S2 (Female). Wristbands: wristband3, wristband4 for S2; wristband2, wristband5 for S1. The subjects performed the test wearing two wristbands, one per wrist. The table below reported the results obtained:						Pass	N/A



6MWT	Trial	wristbands connected to the App	Steps Performed	Steps recorded by Nestore		Err %		Elevation Gain (Meters)	Elevation Gain (Meters)
Male	1	No	690	wristband 2	wristband 5	wristband 2	wristband 5	wristband 2	wristband 5
	2	No	720	705	705	2.174	2.174	0	0
				732	732	1.667	1.667	0	0
6MWT	Trial	wristbands connected to the App	Steps Performed	Steps recorded by Nestore		Err %		Elevation Gain (Meters)	Elevation Gain (Meters)
Female	1	No	720	wristband 3	wristband 4	wristband 3	wristband 4	wristband 3	wristband 4
	2	No	738	695	675	3.472	6.250	0	1
				712	710	3.523	3.794	0	2
						Female Male Err %			
						2.174	2.174		
						1.667	1.667		
						3.472	6.250		
						3.523	3.794		
						Mean %	2.709	3.471	
						Dev Std %	0.934155294	2.062785153	

Note: The Evaluation Gain value can be slightly greater than zero such as 2 meters even if the test has been executed without height difference.

TC_10

Structured activity – Profile 2

Subject involved: S1 (Male), S2 (Female).

Wristbands: wristband3, wristband4 for S2; wristband2, wristband6 for S1.

Note: this test has been executed also using the wristband6 updated with the FW version 1.5.9 to perform Heart Rate evaluations.

The test has been performed to evaluate the Heart Rate data acquired simulating two different session:

- 1) Rest position (about 1 minute), stairs climbing (about 1 minute), rest position (till time elapses)
- 2) Rest position (1 minute), stairs climbing (about 1 minute), stairs going down (about 1 minute), rest position (till time elapses).

In both cases the Heart Rate trend shall increase when the subject climbs the stairs or goes down, whereas it shall decrease during the last rest position.

The figure below shows the trends obtained during the executions listed above, nevertheless the subjects or the wristband, the behavior is the one reported below.

Pass

N/A



	<p>Heart Rate - Session 1</p> <p>Heart Rate - Session 2</p>		
<p>TC_11</p>	<p>Wristband power off – Battery charge Wristbands used: wristband1, wristband2, wristband3, wristband4, wristband5, wristband6. The wristband has low battery. Turn it off, then attach it to the dock in station. Check the screen is turned off, wait for about 1 hour and check that the battery level is greater than before.</p>	<p>Pass</p>	<p>N/A</p>
<p>TC_12</p>	<p>Wristband power on – Battery charge Wristbands used: wristband1, wristband2, wristband3, wristband4, wristband5, wristband6. Turn on the wristband. Connect the wristband to the App and set the current date/time. Disconnect the wristband from app. Attached it to the dock in station and check the screen of the wristband notifies the battery is in charge. The wristband is not available for BLE connection for about 60 seconds.</p>	<p>Pass</p>	<p>N/A</p>
<p>TC_13</p>	<p>Wristband power on (without setting data/time) – Battery charge Wristbands used: wristband1, wristband2, wristband3, wristband4, wristband5, wristband6. The wristband has low battery, turn it off and then turn it on. Do not set the current date/time and attach it to the dock in station, Check the screen of the</p>	<p>Pass</p>	<p>N/A</p>



	wristband displays the smartphone icon to start. Wait for about 1 hour and check that the battery level is greater than before.		
TC_14	<p>Wristband App connection – Battery charge</p> <p>Wristbands used: wristband1, wristband2, wristband3, wristband4, wristband5, wristband6.</p> <p>Turn on the wristband. Connect the wristband to the App and set the current date/time. While the wristband is connected to the App, attached it to the dock in station. Check the screen of the wristband notifies the battery is in charge, and on the App check the connection status is "Connected". In this condition the battery is not in charge. Disconnect the wristband from the app, try to connect the wristband, the request ends for timeout. Check the wristband is not connected, the battery is in charge.</p>	Pass	N/A
TC_15	<p>Wristband – Battery time duration</p> <p>Wristbands used: wristband4, wristband5.</p> <p>The wristbands are fully charged. They are turned on and configured. During the test, five environmental and five social beacons are in the working range of the wristbands.</p> <p>At the end of the test, the battery time duration is about 18 Hours. When the battery reaches the 0%, the working time of the wristband is about 5 minutes.</p> <p>The estimated time to reach the charging level of 90% is about 4 hours.</p> <p>The estimated time for a complete charge is about 5 hours.</p>	Pass	N/A

Conclusion

At the end of this Ad-Hoc testing, 15 tests have been successfully performed.



9.3. Annex 3: Installation instruction for Sleep sensor

Prerequisite: the device is configured following the installation manual.

Two leds start to blink. A led blinks every second with a green light. The second led blinks with an orange led every 30 or 60 seconds depending on the configuration settings on the device.

The cloud server is an nginx reverse proxy with some custom configuration to forward /data/push/ to ActiveMQ murata.cloud topic. The device messages are sent by the cloud proxy to ActiveMQ murata.cloud topic. The topic can be subscribed as a regular MQTT topic or using a REST construct. Both methods work on nestore-cloud private network (any VPS has access to it).

For testing, the MQTT command is used:

```
mosquitto_sub -h 10.100.1.251 -t murata/cloud
```

(10.100.1.251 is the IP of the development ActiveMQ server that exposes the MQTT interface. For production environment use 10.100.1.230)

if data are received, it means that the device is correctly installed.

Example:

```
$ mosquitto_sub -h 10.100.1.251 -t murata/cloud
```

```
Client mosqsub|20956-gw1.nesto sending CONNECT
```

```
Client mosqsub|20956-gw1.nesto received CONNACK
```

```
Client mosqsub|20956-gw1.nesto sending SUBSCRIBE (Mid: 1, Topic: murata/cloud, QoS: 0)
```

```
Client mosqsub|20956-gw1.nesto received SUBACK
```

```
Subscribed (mid: 1): 0
```

```
Client mosqsub|20956-gw1.nesto sending PINGREQ
```

```
Client mosqsub|20956-gw1.nesto received PINGRESP
```

```
Client mosqsub|20956-gw1.nesto received PUBLISH (d0, q0, r0, m0, 'murata/cloud', ... (2463 bytes))
```

```
<Data version="1.7" xmlns="urn:wsn-openapi:sidf">
```

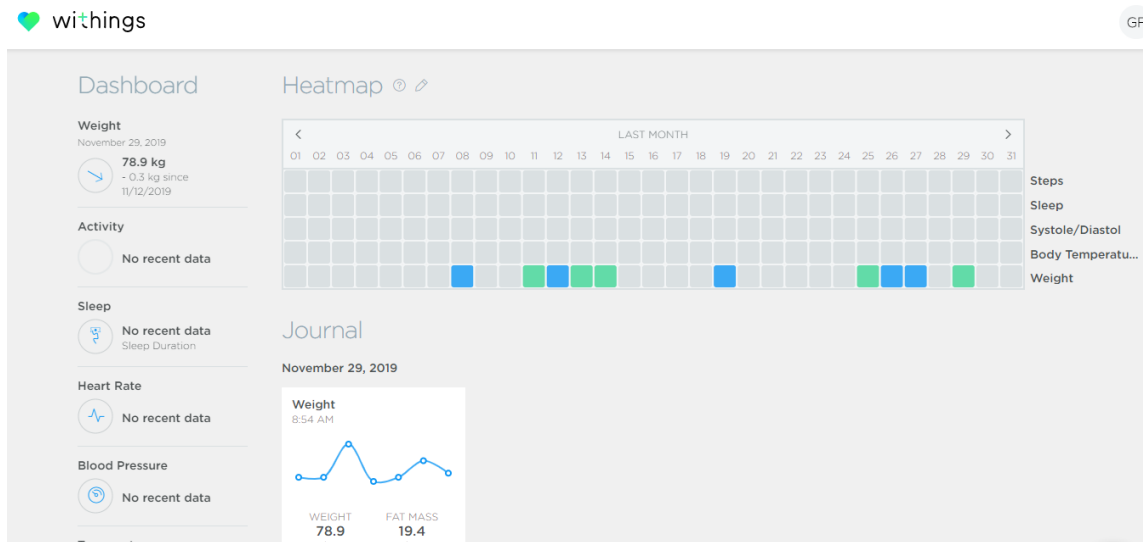
```
(raw data)
```



9.4. Annex 4: Smart Scale Installation instruction

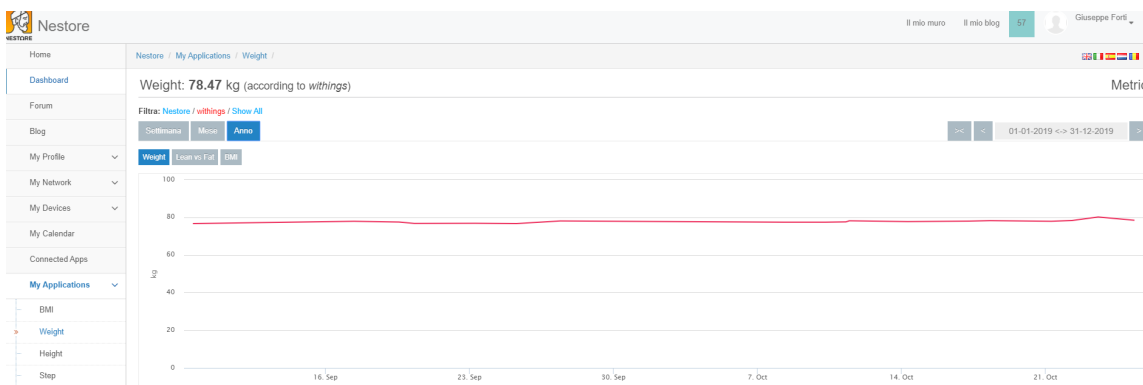
Prerequisite: the smartscale is installed following the manual for installing the SmartScale “SmartScale - Installation how to”.

After the first weigh-in, check on the Healthmate app if the weight is correctly shown. Go to <https://account.health.nokia.com/> and see on the timeline if the weight value is correctly shown.



Go to <https://my.nestore-coach.eu/group/your-community/apps/weight> and check if the weight value is correctly shown.





If not, go to <https://my.nestore-coach.eu/group/your-community/connected-apps> and click on the “Synchronize all sources” button.

The screenshot shows the 'Connected Apps' section for 'Ziva Care status'. It features a 'Connect Health data' button and a 'Synchronize all sources' button. Below, a table lists data streams for the 'withings' source.

Sorgente	Attività	Data Streams	
withings 0 requests	Last sync: 11/29/2019 15:55:06 Can sync again: Yes	Sleep(0), Body fat(0), Activities Summary(0), Blood pressure(0), Weight(0), Blood Oxygen(0), Heart Rate(0), Heights(0), Sleep Summary(0), Weight Goals(0), Body Water(0), Body Bone Masses(0), Muscle Masses(0)	Synchronize streams

