AAL Programme

AAL-CP-2018-5-149-SAVE

01/09/2019 - 31/08/2022

AAL Programme

Project - SAfety of elderly people and Vicinity Ensuring - "SAVE"

Deliverable: D.1.4 Users Interfaces: APP and UX design

Version: 1.0

Main editor: VS

Contributing partners: ISS

Table of contents

1. Recommendation for UI and UX - a literature synthesis....4
1.1. UI design and development requirements....6
2. The e-Health system....8
2.1. Mechanical component....8
2.2. Software component....11
3. Smartwatch interface....11
4. SAVE web application....13
4.1. Scheduled notifications....13
4.2. Real-time tracking service....14
4.3. Localisation....14
4.4. Compatibility and accessibility....15
5. Admin Centre web application....15
5.1. Dashboard module....17
5.2. RO Data module....17
5.3. Kit Data module....18
5.4. Kits module....18
5.5. Devices module....18
5.6. Device types module....20
5.7. Users module....20
REFERENCES....21

1. Recommendation for UI and UX - a literature synthesis

UI and UX are two of the newly most used acronyms in developing an application lately. User Interface (UI) and User eXperience (UX) are two terms that define two different concepts which are closely connected. They are all about the interaction between an application and its user.

UI / UX describes a set of concepts, guidelines, and workflows for critically thinking about the design and use of an interactive product [1].

The user interface is the graphical layout of an application. This includes screen layout, transitions, interface animations and every single micro-interaction.

The user's experience of the app is determined by how they interact with it. It has to answer several questions about this topic. User experience is determined by how easy or difficult it is to interact with the user interface elements that the UI designers have created [2].

User interface design becomes iterative because after finishing an initial design the designer usually asks: Can it be made better? And the usual answer is "yes". Software design, especially user interface design, is naturally iterative, because software allows changes as long as engineers want to make changes for enhancements or experiments. After the initial design is created, software design continues to evolve through iterations, experiments with prototypes, or incremental development [3]. "Because software is so malleable, software design is a continuous process that spans the entire lifecycle of a software system; this makes software design different from the design of physical systems such as buildings, ships, or bridges" [4].

Advanced design principles along with effective strategies may lead to innovative user interface design. There are several principles regarding this topic including the following:

- Examine promising alternatives from the widest range of possible alternatives in order to provide the best user experience through integration of various features including hardware, software, artistic, mathematical and intuitive aspects.
- Let subject matter experts play a leading role in all phases of the design.
- Utilize Object Oriented Design concepts throughout the development process.
- Push the design-review-design cycle to its limits.
- Consider separation of concerns in order to deal with all interactions among system elements.
- Consider design principles as well as HCI (human-computer interaction) data and user experience for innovative user interface solutions.
- Include only those action features which are intuitively learnable; transform others to this category or to an automated category.
- Maximize cohesion and minimize coupling among components.
- Include error prevention and simple error handling.
- Present user interface design at multiple levels of abstraction.

Ageing population represents a concern in most developed countries. The burden of caring for elderly population must be sustainable and research shows that keeping older people as self-

sufficient as possible in their own homes is the best way to manage this. Many of the technological solutions trying to achieve it rely on the usage of information systems in order to automate or increase efficiency in caregiving sectors. Hence, user interface design, which is concerned with various aspects of human-computer interaction, needs to carefully consider elderly people's requirements in order to achieve targeted outcomes, this topic bringing forward several challenges.

As the authors group them, there are three high levels of challenges that elderly users experience with user interfaces. Overall, there could be stated that these challenges are related to physical issues (impaired eyesight, haptic deterioration, reduced hearing), computer experience (unfamiliarity with interface, limited understanding of processes, un-intuitive controls) and cognitive issues (attention, working memory, long-term memory).

Starting from this point, there are solutions that are trying to achieve a better user experience for the elderly people, eighter involving the users in the process of design or not. However, there are four high level categories for these ideas:

- Interface and Control Design – text and object standards (established standards regarding text size, colour and font), intuitive control elements (simple controls enhanced by images or icons to imitate the action), confirmations and errors (controls that explicitly state the action occurring in the system), context help (context sensitive help providing information about the currently selected feature).
- Input Controls – touch input (touchscreen-based interfaces, rather than keyboard and mouse), voice input (navigation and commands using audio commands), eye-gaze input (a type of input using the users eye motions), TV interface
- Natural language (using plain descriptive language for commands, avoiding jargon)
- Cognitive Evaluation (testing usability focusing the type of learning an understanding that could be affected by cognitive deterioration) [5]

Lately, the technological evolution leveraged the development of smart devices and also smarter software. Hence, there are a lot of mobile devices of many capabilities to choose from. This diversity has also been adopted by the elderly people as they come more and more in touch and comfortable with smartphones and tablets.

Therefore, user interface designers should consider the usability of physical devices capabilities, the purpose, and the relationship of mobile devices with seniors and interactions techniques.

Using that as a starting point, there are some recommendations for having a better outcome.

- Regarding physical devices capabilities:
    - Large, bulky mobile phone is recommended, but also it should fit in the pocket
    - Rubber grip, phones that are easy to hold and provide haptic aids
    - Big or raised buttons for easy recognition
    - Minimum background or external noise, fitting and comfortable headset
    - Quick-dial pre-programmed or “panic” button, quick last number dial
    - Battery energy saving for long usage and battery level reminder

- Regarding Interface Design:
  - The key concept for designing senior-friendly user interface is simplicity, consisting of a home screen with few main features
  - Larger icons and fonts, their colours, a bigger screen size and familiar icons/images and sounds
  - Larger font size and screen contrast for an enhanced visibility
  - Photo-realistic icons
  - Avoid unnecessary scrolling
  - Highlight important functions using colours (to avoid short wavelength colours), different shaped icons
  - Clear and simple terminology
  - Personalized interface
  - Illuminated keypads (if it is needed)
  - Own phone number and current date displayed on the main screen
  - Caller identification – caller photo
- Regarding Interaction Technique
  - Provide feedback – sound, touch, and visual effect on key press
  - Simple input methods, perhaps enhanced by speech input commands
  - Easy way of unlocking the device
  - Use of touch screen devices
  - For visual impairment usage of speakers and text-to-speech feature
  - For auditory impairment usage of loud ringtones, audio reminders
  - For reduced touch sensitivity usage of large keys and well-spaced keypad [6][7]

1.1. UI design and development requirements

Possible implication in software design according to cognitive decline in the elders:

- **Vision**: one of the most appropriate texts for information display is ***sans-serif fonts*** with the ***size between 12 and 14 points*** (*Morrell, 1996*) - the width of the visual field of elderly people reduce
- **Colour**: older people have ***less sensitivity to color contrast*** especially in the ***blue green range*** (*C. Owsley, 1983*); designers ***should not use colors to communicate meaning***, but should use for supporting information presentation
- **Memory**: the average of the related items to be shown in the display panel used for the older people should be around **5.5 items** (*J. Botwinick, 1974*) - for older people, use of long term memory is much more effective than short term memory
- **Sound**: the devices that require sound as alarm, instruction or any activity that require attention from the elderly users should use the ***lower range of frequency*** (between 500 and 1000 Hz) - high pitched sounds with peaks over 2500 Hz are mostly missed by the elderly (*Berkowitz J.P., 1990*)
- **Attention and Simplicity**: the use of ***relevant graphics and pictures*** are more significant than the use of detailed decorations; ***multitasking*** operations ***should not be***

applied as well - older adults have problems maintaining attention over long periods of time (*Vercruyssen, 1996*)

- **Motor decline**: small screen on mobile devices may limit usage of elderly users, but a tablet device still have mobility and is still not compromised with screen size - physical decline is one of the general problems for the elders
- **Reduction of complexity**: the design of the interaction should ***avoid complexities***, for example using short and long press, using combination keys, using multi fingers, using multi touch, etc - ***simpler is more useable for elderly users***
- **Clear structure of tasks**: clearly separated task is the factor that may increase usage performance for elderly - single task per page reduce attention load for older users
- **Consistency of information**: navigation bars, labelling or any interface components should be used ***to communicate exactly where the users are in the application*** - elderly users are easier to recognize information than to recall memory
- **Rapid and distinct Feedback**: feedback of every action should be provided within a certain time and it should indicate result or response of each action – due to limitation of short-term memory of older adults
- **On screen help**: On screen help within operation page should be used - older people have anxiety of using new products
- **User support**: reduce usage of error messages to become as low as possible; in case that error messages have to be shown, error messages should be simple, precise, polite and understandable - elderly users are sensitive for errors from their actions

Interface optimization (according to the limitation of motor skills and cognitive abilities of the elderly people):

- Make use of proper size interface components:
    - Touch sensitive area/Size of button should be 16.5 mm to 19.05 mm
    - Spacing size between button/touch sensitive 3.15 mm to 12.7 mm
- Avoid using scroll bar
- Keep operation area in the centre of working page
- Make use of multi model communication
- Make use of real object-liked interface
- Present text the simplest way:
- Size 14 (~5mm on 72 dpi screen) or higher
    - Make use of sans-serif fonts
    - Make use of black font on white background
    - Avoid using fancy text (moving, non-horizontal orientation, splash etc.)

2. The e-Health system

2.1. Mechanical component

UX design is a feature oriented on the study of the end-users, tackled along the project through co-design and co-creation sessions. Regarding the functional model, UX design was taken into consideration on several different levels, from mechanical point of view to software development. The main purpose was that the design is intuitive and efficient, the procedures are logical and the elders may complete the tasks with minimum effort.

The mechanical prototype was designed using SolidWorks CAD software and was the result of several meetings that helped to draw a general guideline of the general aspect, that was later refined during the development. The resulted files were exported as *STL files and later 3D printed on an UpBox 3D printer using ABS filament.

The main foreseen features are:

- High touch case concept
- Easy access to biosensors
- Simple sensors repository
- Natural approach handling
- Robust design
- Ergonomic control panel

The enclosure was designed in the form of a tower with drawers with the devices and sensors incorporated (Figure 1), first to facilitate the access to biosensors but also in order to build up the elder`s trust by using a natural movement that they are used to, namely pushing and pulling the drawers. On the top of the structure there is a TFT screen placed on a 14-degree angle in order to facilitate reading the information displayed and an On/Off button, whereas the battery is positioned in the lower part to gain easy access to charging ports.

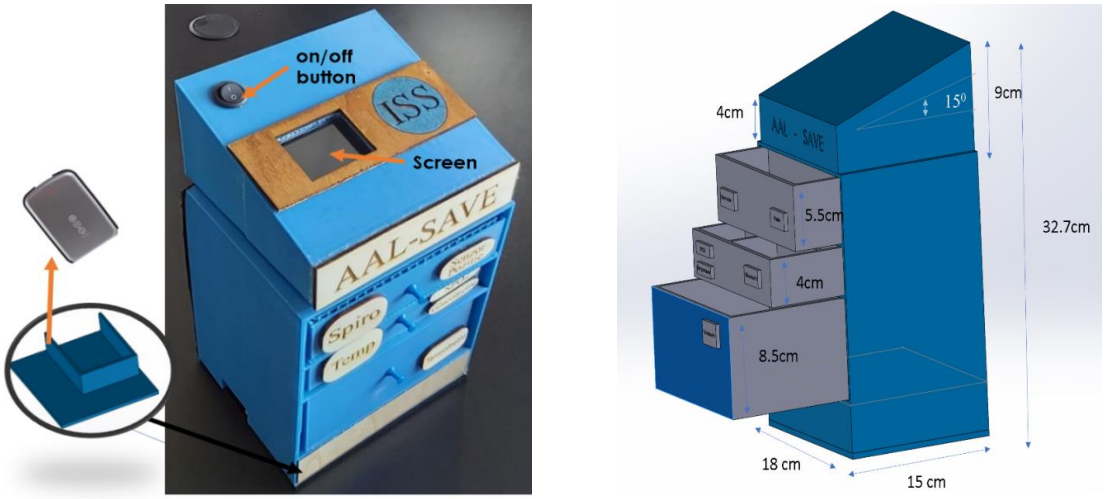

Figure 1 - Device assembly - left physical prototype and right 3D model design

All components have their own specific place, and all drawers are marked accordingly so the elders can go straight forward to measure their vital parameters as seen in figures 2, 3, 4 and 5.

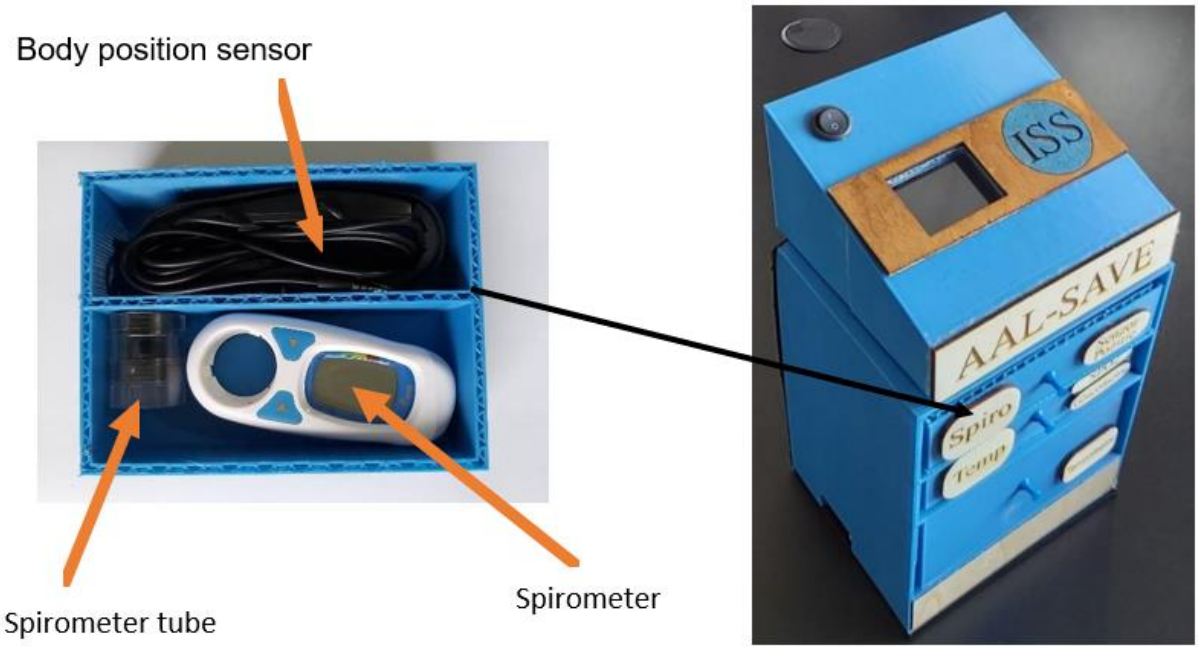

Figure 2 - Fist drawer interior compartments and sensors

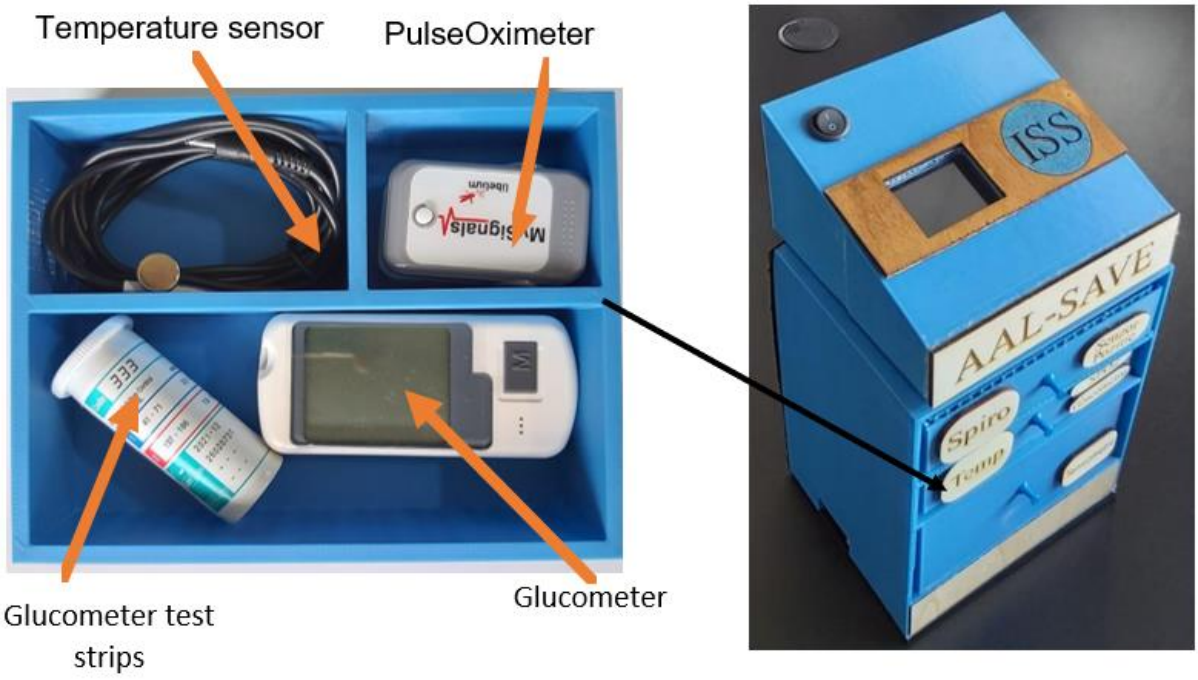

Figure 3 - Second drawer interior compartments and sensors

Figure 4 - Third drawer interior compartments and sensors

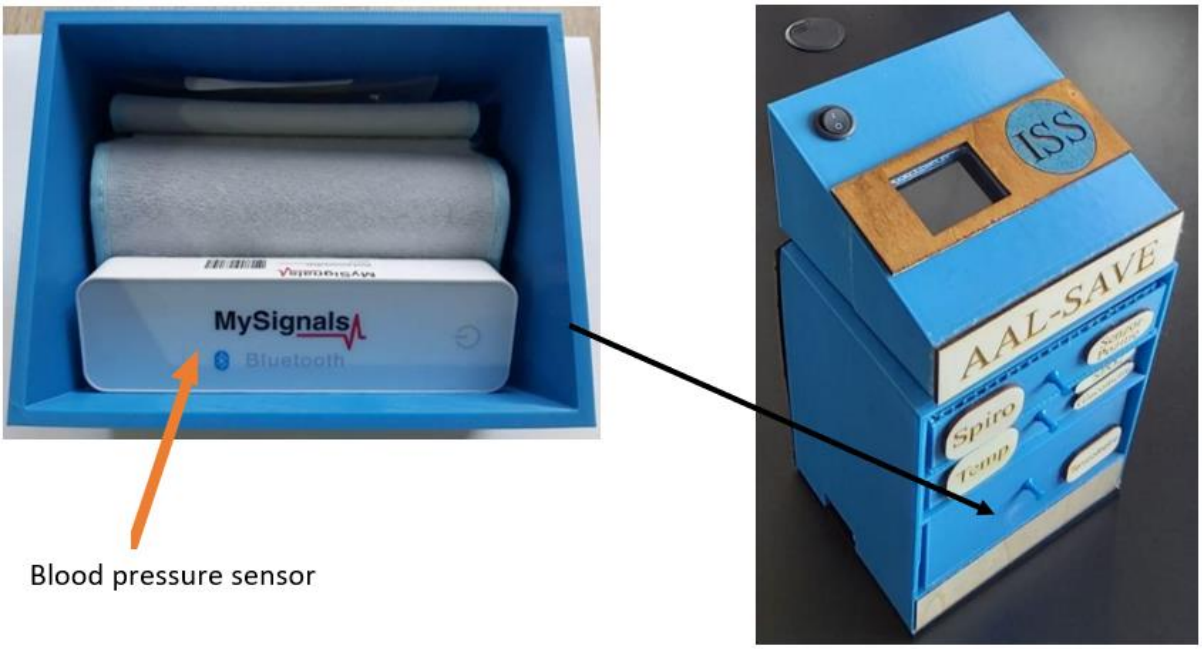

Figure 5 - Bottom interior compartments and sensors

2.2. Software component

Considering the user interface component, if the elder is properly using the device, on the TFT display is shown a list of available sensors (Figure 6) and further he can acquire data that is automatically processed by the system. Following this step, the system offers two different regimes that can occur in parallel:

1. The first regime is represented by the **development and serviceability mode** where the biometric data read from the sensors is visible on the screen and further transmitted over internet to Information and Communications Technology (ICT) development teams
2. In the second regime, which is the main User Interface used by the elders, the data from the sensors is not shown on the screen and is just transmitted over the internet to caregivers or volunteers. The need resulted from the co-design sessions and was required by the stakeholders.

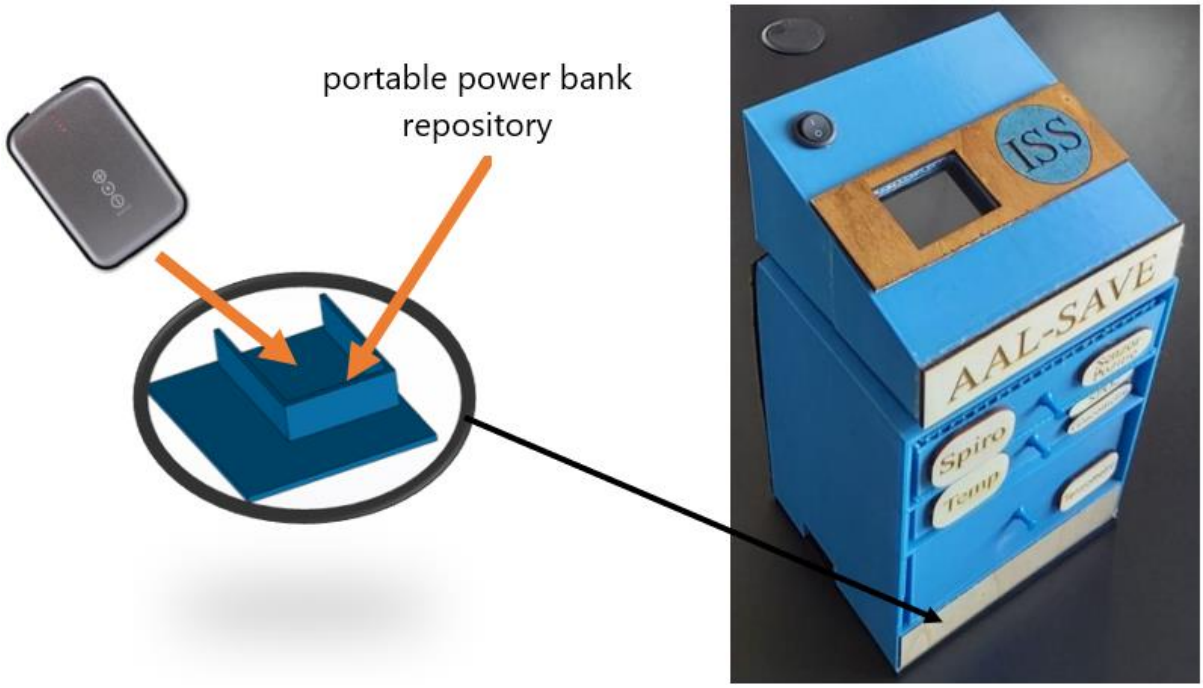

Figure 6 - TFT screen showing the list of available sensors

3. Smartwatch interface

For the smartwatch, a specific SAVE interface was developed in the form of a watch face, which fulfils a double role: wearable user interface for the elderly, regardless of his/her location (inside or outside the home), and wearable sensor (for basic biological signals - pulse, activity monitor - and location).

The watch face is customized according to the SAVE visual identity (as shown in Figure 7) and shows a minimal set of information, as resulted as a requirement from co-design sessions of WP2. For the configuration of the connection to the SAVE cloud application (done one time), a separate application has been developed.

An update of the interface is planned for the next period, in order to accommodate any other outputs from WP2.

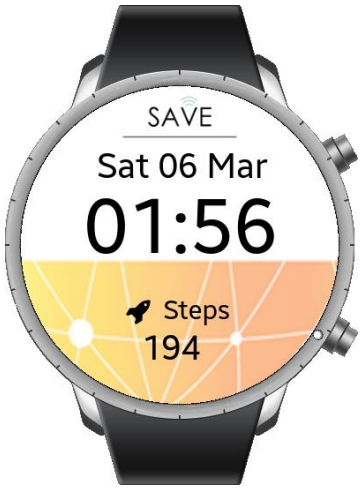

Figure 7 - SAVE watchface

The watch face has been designed to display in an aesthetic and efficient way the necessary information and to collect data provided by the sensors, the location and to display the notifications defined by the user (end-user and/or caregiver) in the web application interface (developed for this purpose), all with a minimum energy consumption.

The configuration application aims to ensure security and identify the user's profile. Once the application is opened, a text box will appear where a 6-digit PIN must be entered (which is associated with the end-user). After pressing the validation button, the authentication will be confirmed or denied by a corresponding message on the screen, along with the instructions needed to continue the process (Figure 8).

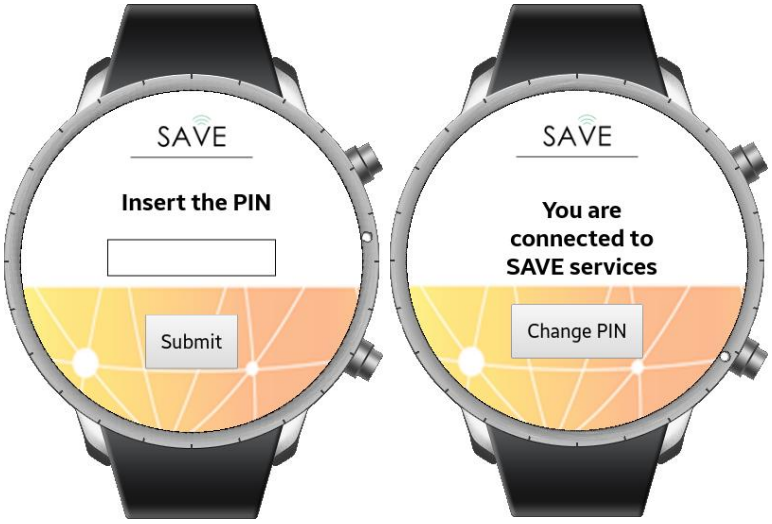

Figure 8 - Registering smartwatch in the SAVE cloud application

4. SAVE web application

The web application has been developed so that end-users (elderly and caregivers) can efficiently and securely access the SAVE solution's features, using a coherent and uniform user interface. This application will be further developed and will offer an even simpler and more intuitive interface for both elderly and their caregivers.

The interface now offers two main features:

- management of scheduled notifications
- real-time tracking service

The data that is currently collected from the server will be displayed in a graphical manner in dedicated pages that are in development at this moment. According to the outputs of WP2, these pages will present the data differently for elderly and caregivers.

4.1. Scheduled notifications

The home page of the web application displays the active scheduled notifications (Figure 9), and it allows the user, which can be the elderly and/or the caregiver, to define new ones.

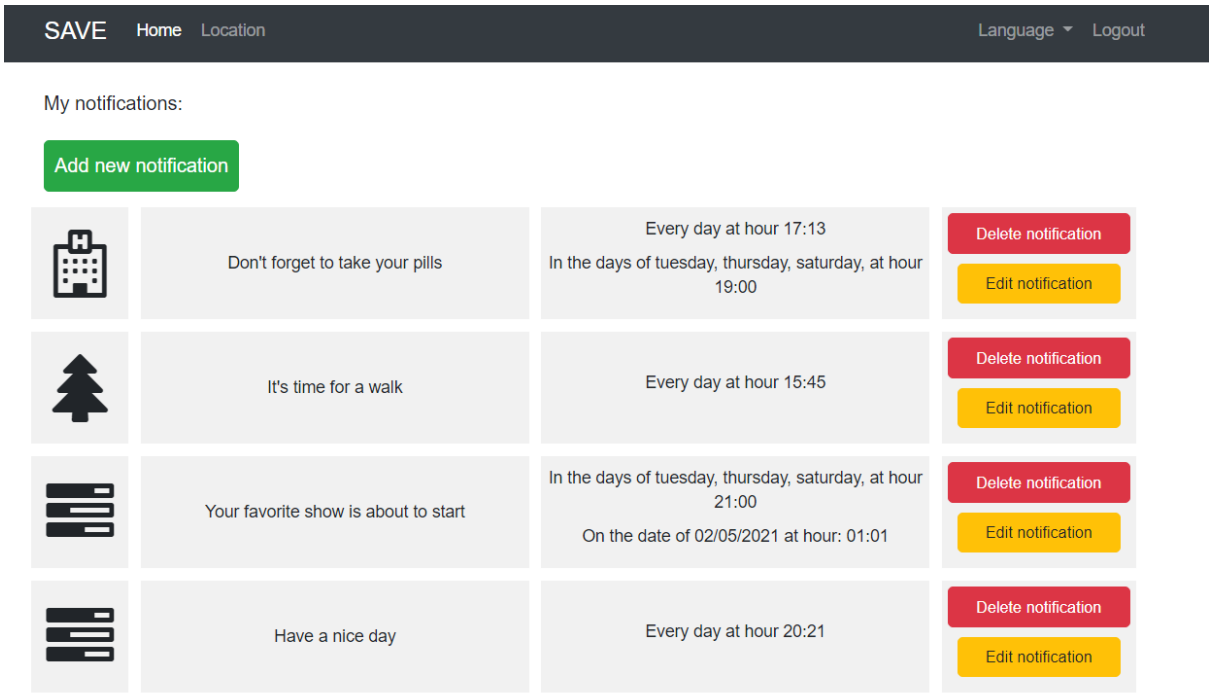

Figure 9 - Active notifications on the dashboard page

The users can customize the notifications according to their needs by typing their own messages, choosing an icon and by setting notification display frequency: every day, on certain days of the week, on a specific date. For each of the previous options, the user will also choose the time when the notification will be displayed.

The application also offers the users the possibility to delete notifications.

4.2. Real-time tracking service

The application offers a user tracking location feature, which can be accessed from the menu bar. A person's current location is marked on a map in real time, together with the location of his/her house and his/her 10 previous locations (Figure 10). This helps caregivers check if the end-user is in a location away from home that they would not normally go to, suggesting that he/she may be disoriented. The distance from home is computed and can be used to raise alarms for the end-users known to have cognitive problems.

The tracking information are kept for a limited time and will be used to detect possible disorientation states of the elderly wearing the smartwatch (e.g. going in circles, going back and forth repeatedly, straying too far from home, etc).

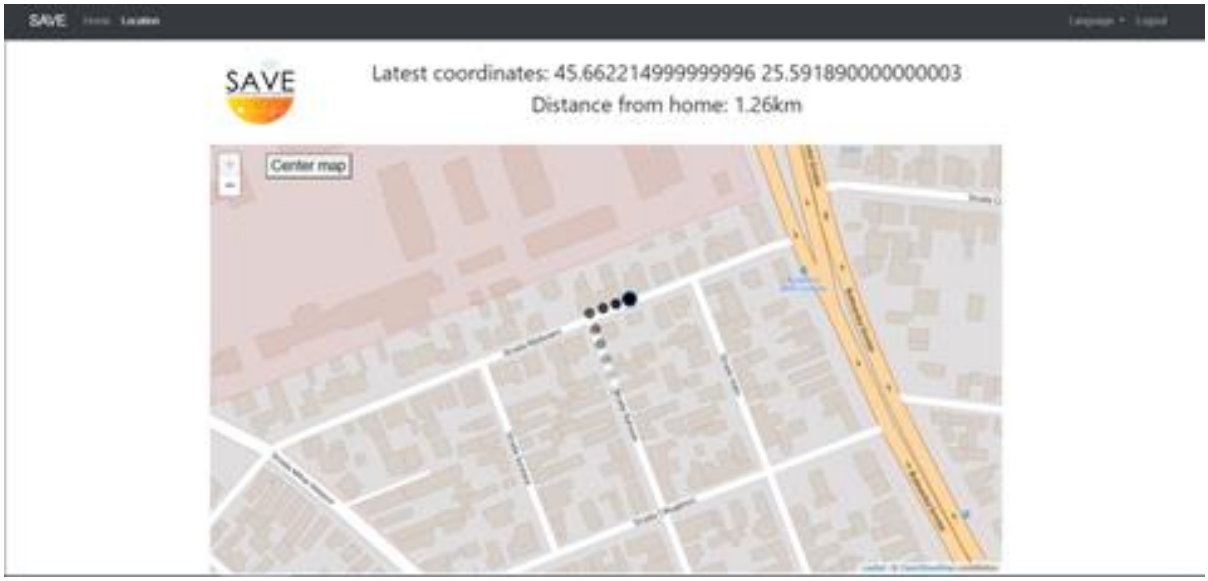

Figure 10 - Tracking location screen

4.3. Localisation

The application is available, at this moment, in 2 languages: Romanian and English, and switching between them can be done using a button in the menu bar on the right.

4.4. Compatibility and accessibility

The SAVE web application is developed as a responsive application, using the Bootstrap library, so the user interface is compatible with all major browsers and with mobile devices (smartphones, tablets) with a wide range of screen resolutions.

5. Admin Centre web application

Admin Centre is a web application developed to manage data efficiently and securely within the SAVE system. The Admin Centre application is on its 3th major version; there were several major and minor versions, as a result of multiple design iterations.

The data collecting process is organized in a hierarchical structure (Figure 11); the SAVE solution recognizes several ***device types***, that are registered in the SAVE database. The ***devices*** are also registered in the database and it is mandatory to associate existing device types to them, so the user interfaces will know how to interpret the data (***values***) coming from them.

A set of devices form a SAVE ***kit***, which is associated with one elderly end-user.

The Admin Centre web application provides all the tools to manage all of these entities.

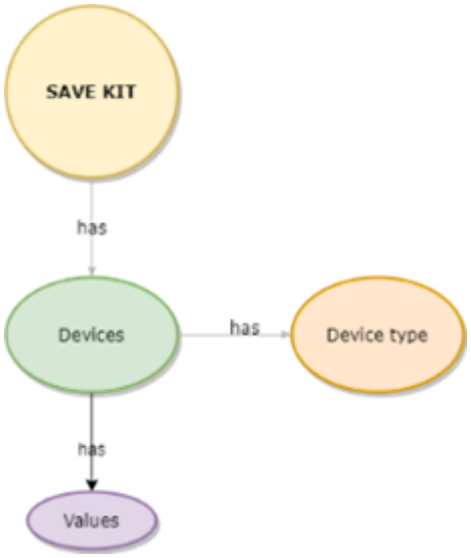

Figure 11 - Data organization in the SAVE system

As stated earlier, a kit contains several devices, and each device is assigned a type that determines how the information is displayed to the user. Devices are identified by a unique identifier (ID), with which the collected data is also labelled. It must be pointed out, that the data is not directly linked with the identity of the user.

The application also offers a pseudo real-time display of the collected data, in the form of cards, and tabular views of data in raw or processed formats.

The Admin Centre web application consists of several modules:

- Dashboard
- RO Data
- Kit Data
- Kits
- Devices
- Device Types
- Users

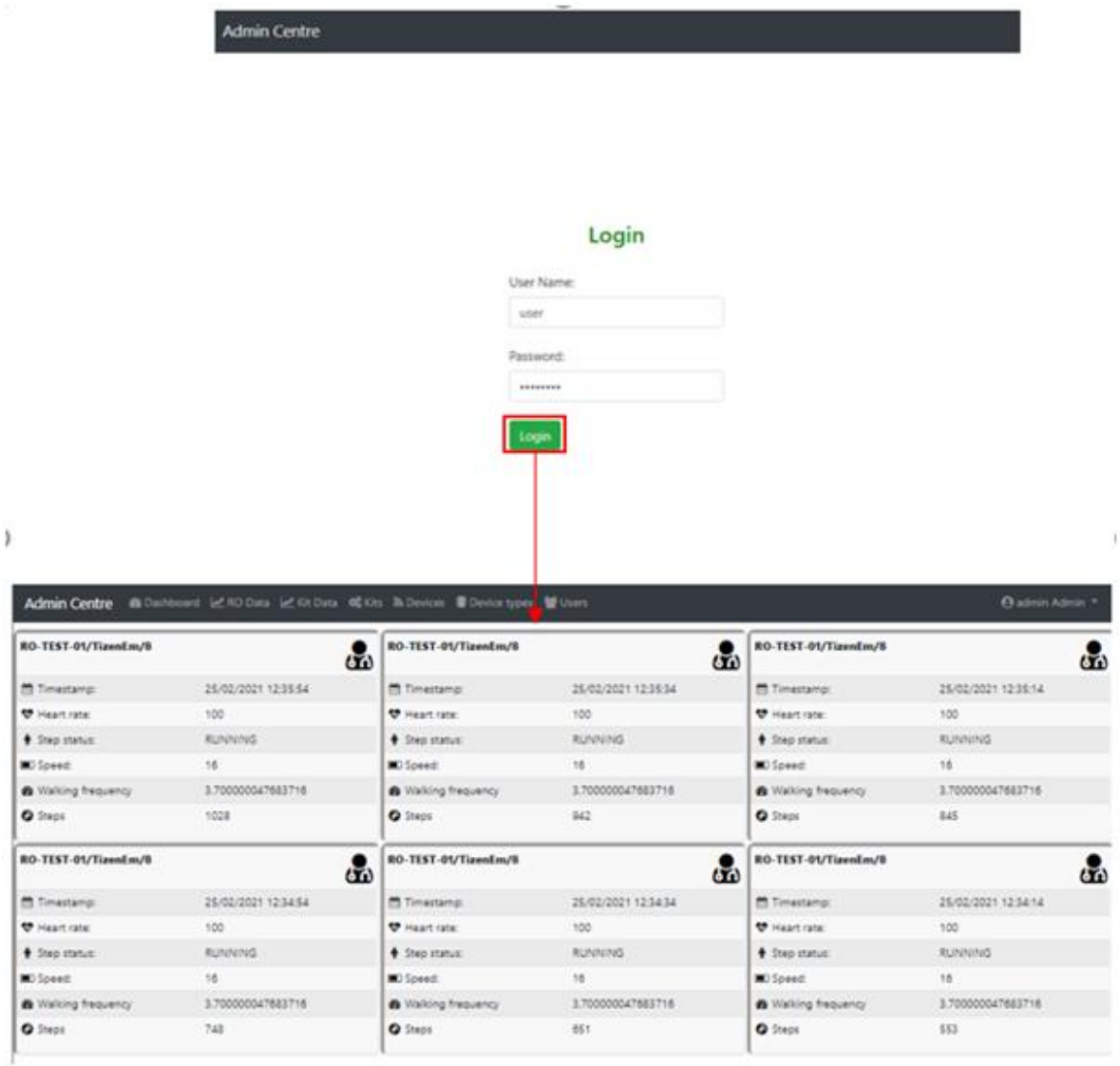

Figure 12 - Login screen and Dashboard screen

The access to the application's features is secured by an authentication procedure based on the username-password pair. Figure 12 shows the Login screen and the Dashboard module.

5.1. Dashboard module

The Dashboard screen contains synchronous viewing of the latest collected data in the form of cards (Figure 13). The Dashboard module has been improved several times (either for a more attractive display, or because of changes in the structure of the collected data), now displaying the desired values appropriately and aesthetically.

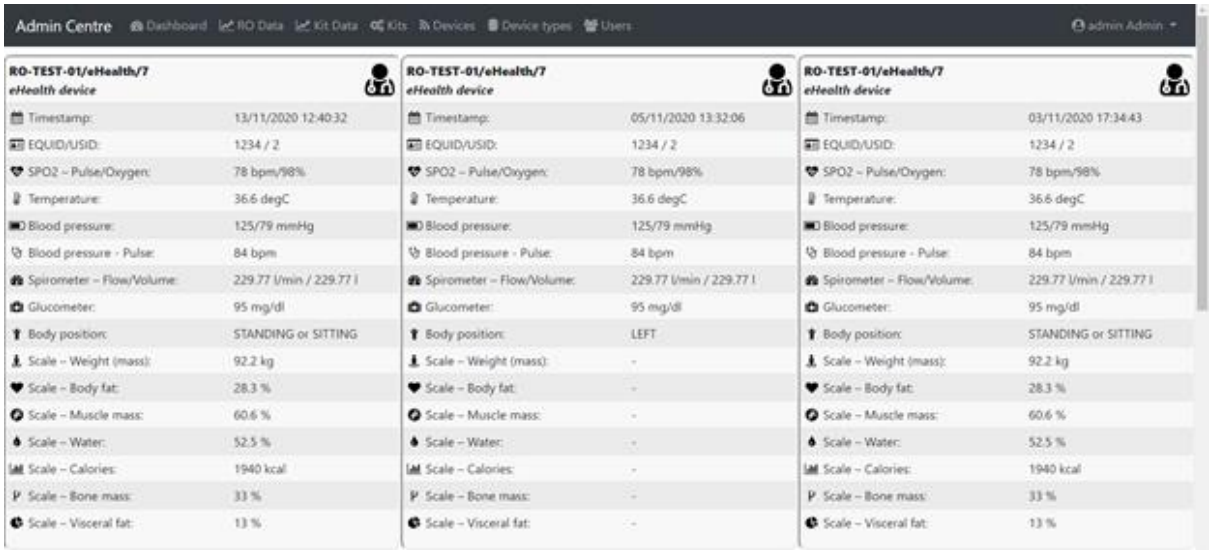

Figure 13 - Dashboard screen

5.2. RO Data module

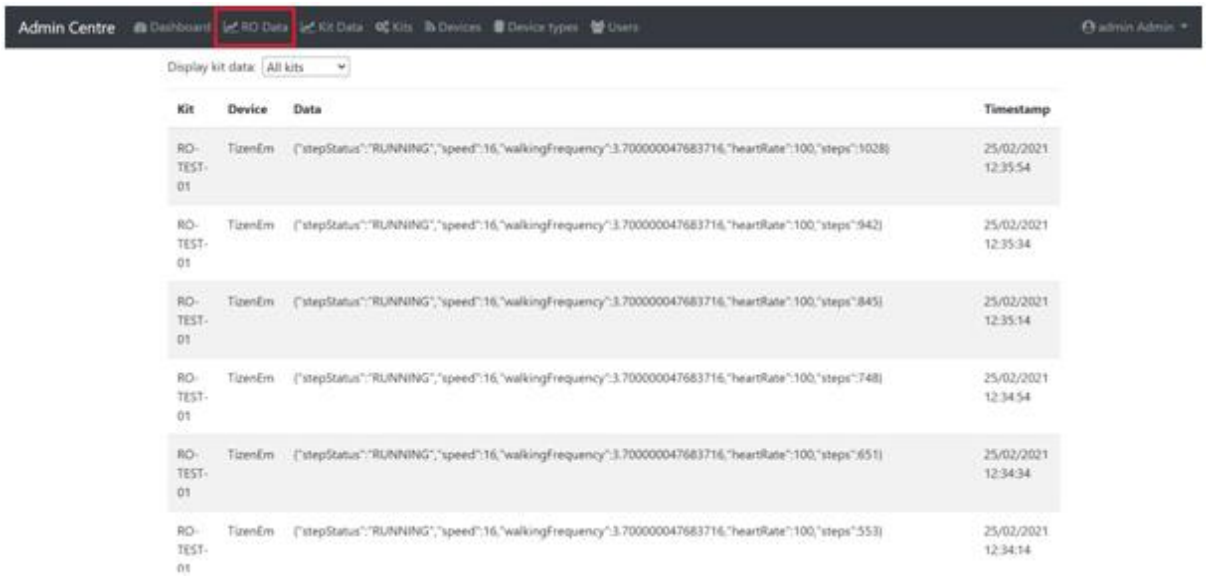

Figure 14 - RO Data screen

This module allows the visualization of the data coming from the sensors, in raw format, as they are received from the adaptation interfaces. It is a component intended only for SAVE system administrators (Figure 14).

5.3. Kit Data module

This module aims to display in tabular format the data, processed to be understood by a user. Figure 15 depicts the component developed for eHealth devices; with the help of filters (device and period), the desired data can be selected for viewing.

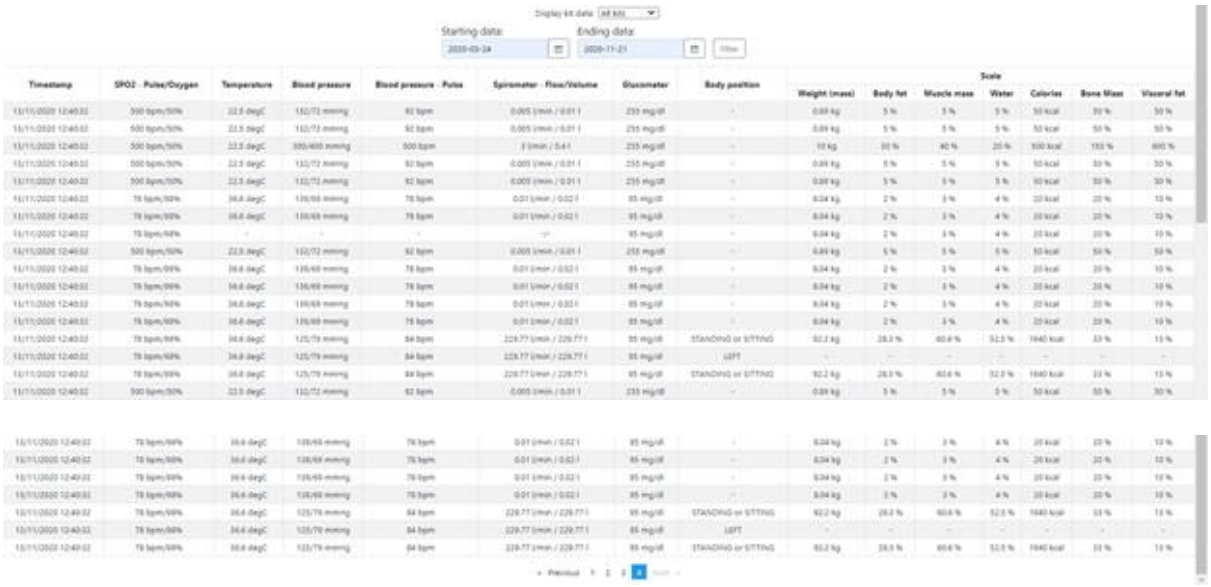

Figure 15 - Kit Data component

5.4. Kits module

This component provides the facility to manage the SAVE kits recognized by the SAVE system (Figure 16).

5.5. Devices module

The Devices module allows adding of a device and record it in a SAVE Kit. Data from unknown devices is ignored by the data collection system.

The devices have two descriptions - one long and one short - that will be used by the user interfaces to allow their easy identification (Figure 17).

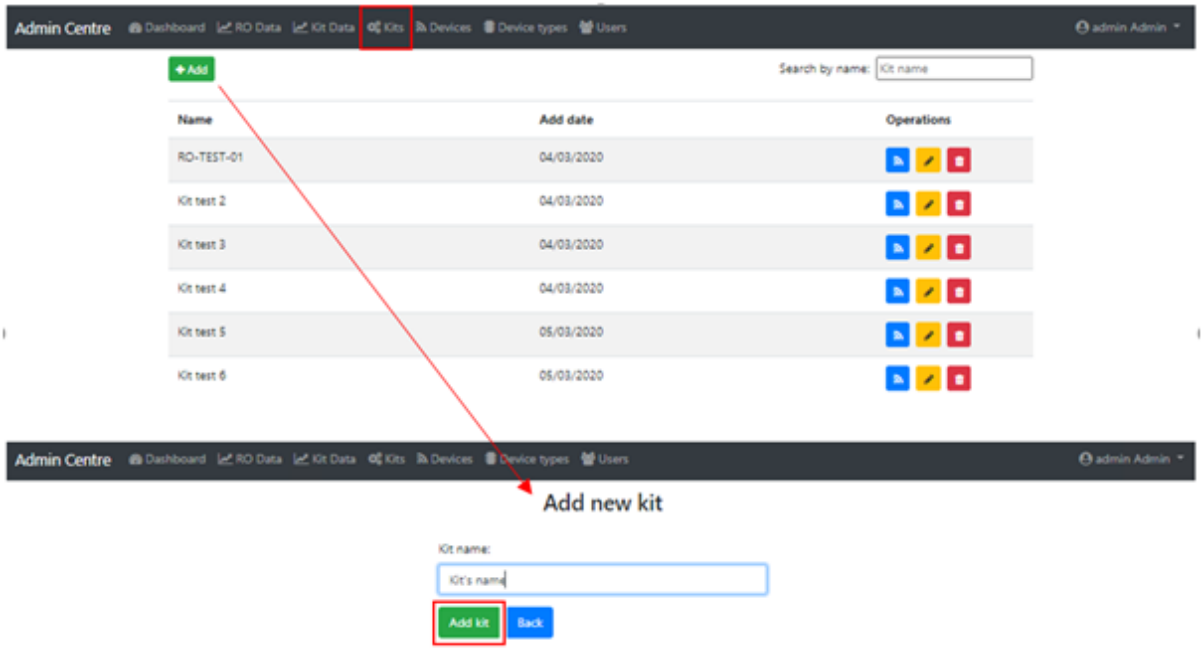

Figure 16 - Kits component

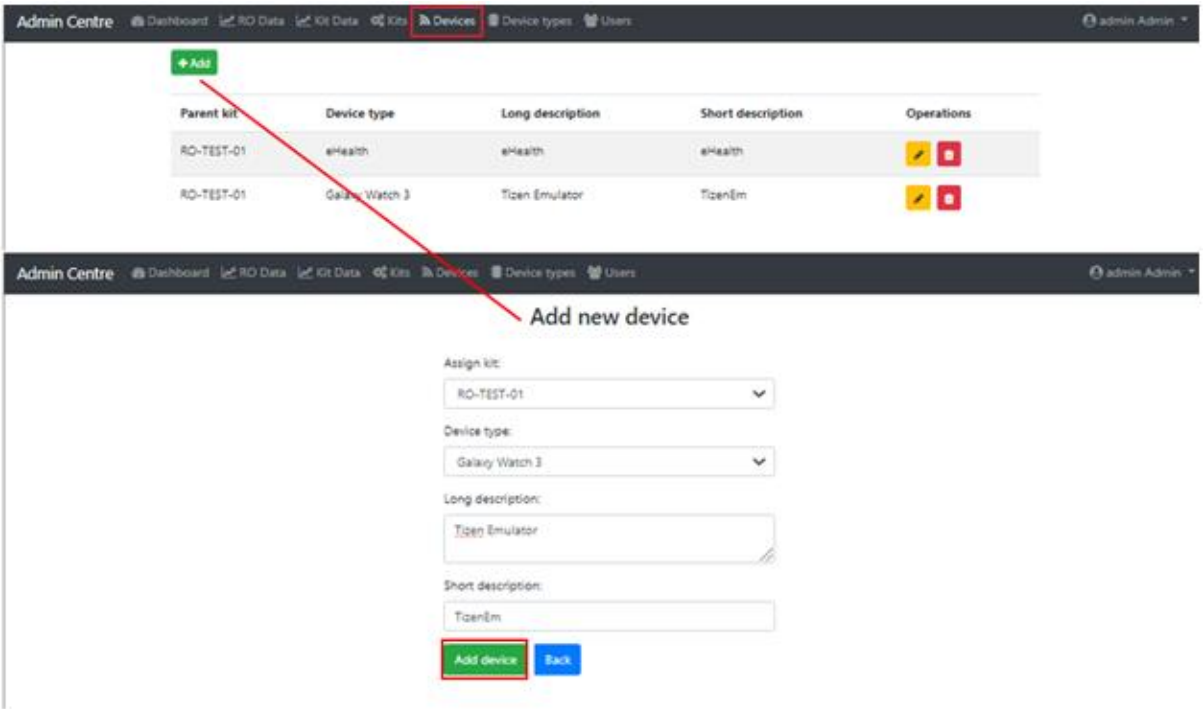

Figure 17 - Devices component

5.6. Device types module

This module allows the management of the types of devices recognized by the SAVE system. This implies the existence of data adapter interfaces and software components included in the SAVE system for viewing and processing data from these types of devices (Figure 18).

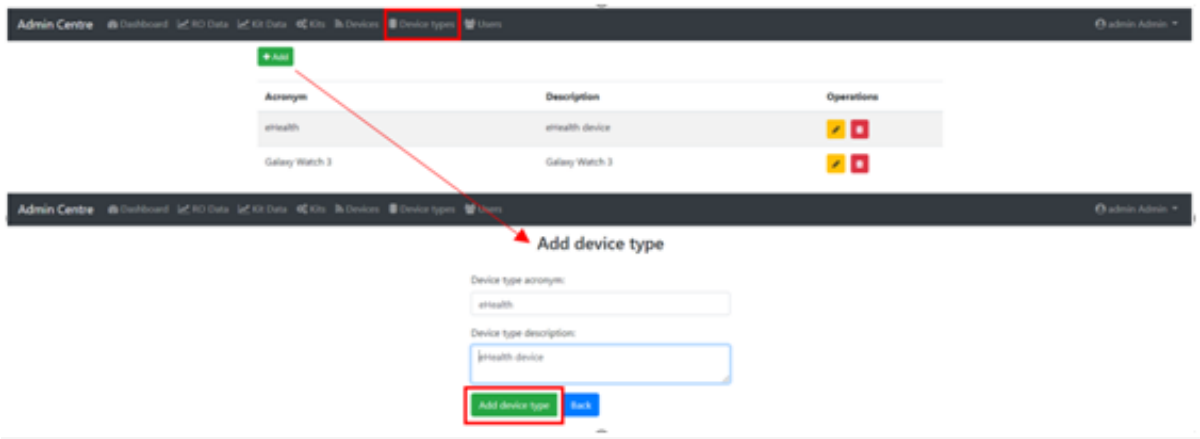

Figure 18 - Device types component

5.7. Users module

The users module offers the tools to register new user into the SAVE systems (Figure 19). They can be grouped in several roles:

- End-users (elderly): can have a kit attached to them
- Caregivers: are linked with end-users
- System administrators: have access to all the modules of the Admin Centre
- Researchers: have access to the collected data for

The end-users and caregivers cannot access the Admin Centre web application, their accounts are only valid for the SAVE web application.

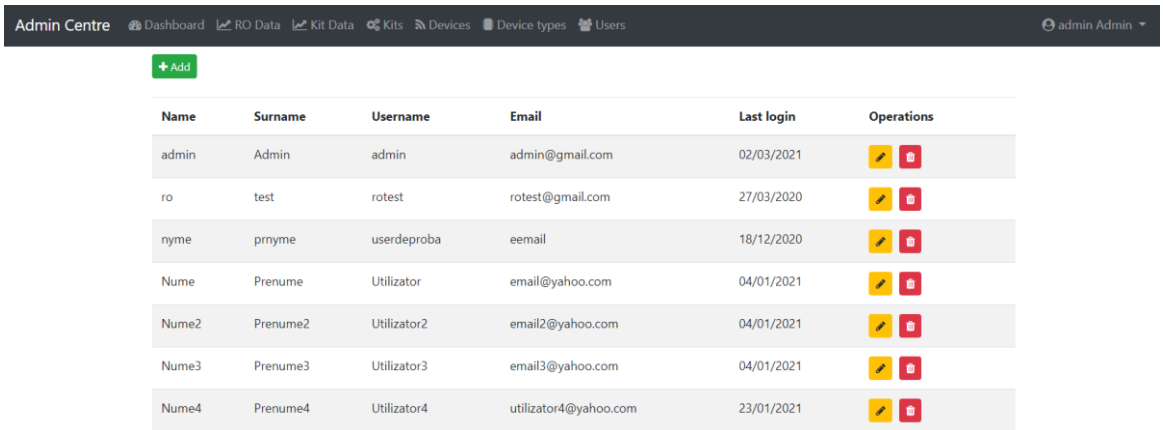

Figure 19 - Users module

REFERENCES

[1] Roth R. E., User Interface and User Experience (UI/UX) Design, Geographic Information Science & Technology Body of Knowledge, 2017, DOI: 10.22224/gistbok/2017.2.5

[2] Difference between UI-UX. Available: https://uxplanet.org/what-is-ui-vs-ux-design-and-the-difference-d9113f6612de

[3] Dey P., Sinha B. R., Amin M. Badkoobehi H., Best Practices for Improving User Interface Design, International Journal of Software Engineering & Applications (IJSEA), Vol.10, No.5, 2019, DOI: 10.5121/ijsea.2019.10505

[4] Ousterhout J., A Philosophy of Software Design, Yaknyam Press, 201

[5] Dodd C., Adam M. T. P., Athauda R., Designing User Interfaces for the Elderly: A Systematic Literature Review, Australasian Conference on Information Systems, Hobart, Australia 2017

[6] Wong C. Y., Mobile User Interface for Seniors: an Impact of Ageing Population on Mobile Design, Design Principles and Practices 4(4):231-248, 2010

[7] Baharum A., Zain N. H. M., Taharudin A., Hanapi R., Guidelines of User Interface Design for Elderly Mobile Applications: A Preliminary Study, Asian Journal of Information Technology 16(1):38-44, 2017, DOI: 10.3923/ajit.2017.38.44