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Deliverable D5.1
Report on TeNDER interfaces

Work Package 5: Services Integration and Technical Validation

affecTive basEd iNtegrateD carE for betteR Quality of Life: TeNDER Project

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The TeNDER consortium consists of the following Partners.

Table 1 - Consortium Partners List.

No	Name	Short name	Country
1	UNIVERSIDAD POLITECNICA DE MADRID	UPM	Spain
2	MAGGIOLI SPA	MAG	Italy
3	DATAWIZARD SRL	DW	Italy
4	UBIWHERE LDA	UBI	Portugal
5	ELGOLINE DOO	ELGO	Slovenia
6	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS	CERTH	Greece
7	VRIJE UNIVERSITEIT BRUSSEL	VUB	Belgium
8	FEDERATION EUROPEENNE DES HOPITAUX ET DES SOINS DE SANTE	HOPE	Belgium
9	SERVICIO MADRILENO DE SALUD	SERMAS	Spain
10	SCHON KLINIK BAD AIBLING SE & CO KG	SKBA	Germany
11	UNIVERSITA DEGLI STUDI DI ROMA TOR VERGATA	UNITOV	Italy
12	SLOVENSKO ZDRUZENJE ZA POMOC PRI DEMENCI - SPOMINCICA ALZHEIMER SLOVENIJA	SPO	Slovenia
13	ASOCIACION PARKINSON MADRID	APM	Spain

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[1] **R:** Document, report; **DEM:** Demonstrator, pilot, prototype; **DEC:** Websites, patent fillings, videos, etc.; **OTHER**; ETHICS: Ethics requirement; ORDP: Open Research Data Pilot.

[2] **PU:** Public; **CO:** Confidential, only for members of the consortium (including the Commission Services).

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Acronyms and Abbreviations

Acronym/Abbreviation	Description
AD	Alzheimer's Disease
API	Application Programming Interface
APK	Android Application Package
APP	Application
BaaS	Backend-as-a-Service
CSS	Cascading Style Sheets
CVD	Cardiovascular Disease
DAO	Data Access Objects
EHR	Electronic Health Records
FHIR	HAPI Fast Healthcare Interoperability Resources
HL7	Health Level Seven International
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
HTTPS	HyperText Transfer Protocol Secure
IQR	Interquartile Range
JPA	Java Persistence API
JSON	JavaScript Object Notation
LTE	Long Term Evolution
Mx	Month(wherexdefinesaprojectmonthe.g.M8)
PD	Parkinson's Disease
RAM	Random Access Memory
REST	Representational State Transfer
SD	Standard Deviation
SSO	Single Sign-On
SWOT	Strengths Weaknesses Opportunities Threats
Tx.x	Task
TeNDER	affecTive basEd iNtegrateD carE for betteR Quality of Life

UI	User Interface
UX	User Experience
VGA	Video Graphics Array
WPx.	Work Package

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Executive Summary

This deliverable presents the work performed, relying on the User requirements and scenarios collected under WP1 and WP2 to define the user's interface of TeNDER and work performed in WP5 related to the design of all graphic assets of the Front-end system layer.

In the WP5 framework activities, wireframes and mock-ups for the user interface graphical definition of the App and Web Platform were developed. These graphical assets were then exploited for the development of the first version of the Patient and Caregiver's hybrid application tested during the first wave of the pilot.

There are three different interfaces provisioned within TeNDER: (1) Web platform (Health professional-oriented); (2) Mobile interface for caregivers and patients; (3) Tablet (patients oriented). These interfaces are currently integrated via open API, providing a set of similar appearance and functionality interaction services.

Based on these assumptions, the following paragraphs describe the first version of the TeNDER web and mobile application. It includes the interaction with the back-end system, the description of the application development methodology, the definition of the technical characteristics of the application's main functionalities, and the web platform from the user's perspective, as well as the description of the screens developed.

1. INTRODUCTION

This deliverable reports on the outcome of T5.2, providing the details on the Interfaces development. The work contained here relies on the user requirements and scenarios collected as part of the consortium work in WP1 and WP2.

There are three different interfaces foreseen within TeNDER: (1) Web platform (Health professional-oriented); (2) Mobile interface for caregivers and patients; (3) Tablet (patients oriented). To this end, the TeNDER's technology ecosystem includes specific technologies such as health bands, motion sensors, microphone, and other similar devices, all to provide useful information of each patient, such as vital signs, capture the movement and gait and recognize the emotional states and changes of patients. This data can then be viewed by each patient through the TeNDER Mobile App. At the same time, more accurate and detailed information regarding the patient's status is provided to carers with the caregiver-oriented Mobile App and a web platform to health professionals.

The report is structured as follows: in Section 2, we explain the methodology, the collection of requirements and the co-creation process, translation efforts, and firebase analytics; in Section 3, the interaction with the back-end, and in Section 4, the composition of the front-end layers. This section includes the description of the technical features of the webpage and the TeNDER app and their compliance with the accessibility standards, as well as input on the functionality and the screens of both the webpage and the app. The last section of the document, namely section 5, is dedicated to the conclusions and next steps leading to the development and final release of the interfaces

2. **METHODOLOGY**

TeNDER interface development started in 2020 with weekly telephone conferences among user partners and the task leader. Partners have drawn several possible approaches for the initial interface mock-ups. The development process continued under the WP02 developed contents (Technical Architecture, Service-matching table, User Stories) and TeNDER system development in WP03 with included requirements for notification, summarized data visualization, and recommendations.

Interfaces were designed to meet the criteria for three end-user groups:

- Patients;
- Caregiver;
- Professional.

During the TeNDER interface development, from the 1st mock-ups to the version deployed in the 1st piloting wave, users were continuously involved in interface development and TeNDER partners performed qualitative analyses of the iterative testing. User partners presented the interfaces to different end-user groups, tested them, and collected their feedback. The feedback from users was being gathered in two cycles for each new version of the interface. Every evaluation cycle was documented, and the results were integrated into the next development steps by technical partners. To achieve an adequate adaptation to the needs of patients with AD, PD, CVD, their caregivers, and professionals, the objective is to explore the user requirements of the participants involved in the project. The methodology proposed to achieve this objective is a descriptive cross-sectional study with cuts in time: pre-pilot, during pilot conduct, and post-pilot.

The participants defined in D6.1 in the section "PATIENTS RECRUITMENT" will be studied. The study will be carried out through data collection with different tools designed for each of the pilot moments (see Table 2).

Table 2 - Type of data collected for user Requirements.

Time	Data collection	Type of Data
Pre-pilot	The TeNDER User Stories	1. Qualitative
	User needs questionnaires and interviews	2. Qualitative 3. Quantitative
Pilot	Researcher's impressions during study conduct	4. Qualitative
Post-pilot	Final Open questions	5. Qualitative

Data analysis: data obtained will be stratified by participant role: patient, caregiver, and professional. Differences by disease and gender will be provided, as well.

1. Quantitative analysis. Frequencies and percentages for qualitative variables, mean and standard deviation (SD), or median and interquartile range (IQR) for quantitative variables, will be obtained, according to the normality study.

2. Qualitative analysis. Responses to open-ended questions were categorized and verbatims were extracted.

2.1 Collecting requirements

Each of the interfaces for TeNDER have been developed based on the user requirements and the scenarios collected.

For the end-user interaction interface's development, the participant's user requirements in each real scenario (where the pilots are developed) are continuously explored. To this end, feedback from patients, caregivers, and professionals is being collected at different stages of the project.

Through collaborative and coordinated work between the technical partners, technologies development experts, the user partners, experts in patients, and most health professionals, it is expected to achieve success in stopping the requirements of use to develop a tool that responds to the needs of patients affected by AD, PD, CVD, their caregivers, and professionals.

Pre-pilot requirements gathering: The first approach was made in the pre-piloting phase. Before the TeNDER system interface's development, the user's requirements were aimed to be explored to adapt the tool to the needs of each of the end-user profiles covered by this project. To this end, two complementary tools were designed. According to the user's diseases and the scenario in which they daily live, the tools offer a complete vision of the needs and opinions of the end-users. Pre-pilot user requirements were explored through:

1. **The TeNDER User Stories**. Via user stories, the real-world and daily requirements of the participants were described, to make TeNDER a digital solution from the user's perspective. These results have been reported in D2.3 in section "2. Real-world scenarios and use cases".
   Based on the patient's disease, each of the user stories developed by the user partners was studied, after which the technical partners proposed the TeNDER services available for each of the needs detected. Through the collaborative work between health professionals and technology experts, usability requirements were obtained concerning:
   - Real scenarios involved;
   - Required functionalities on mobile devices;
   - Required functionalities on computer devices for settings and notifications;
   - General services of TeNDER.

2. **User needs questionnaires and interviews**. Questionnaires and interviews were carried out in all countries involved in the project (Germany, Italy, Slovenia, and Spain) by the user partners, targeting each end-user profile: patients, carers, and professionals.

The results are reported in section D2.4 "Summary of user needs in the pre-piloting phase" and serve as a basis for the adapting of the technology to the target population and exploring the general characteristics of the participants concerning:

- Socio-demographic characteristics;
- Previous technology use habits and technical affinity;
- Type of support needed;
- The overall opinion about the TeNDER system from the participant's perspective;
- The opinion on possible functionalities offered by TeNDER;
- Preferences and main concerns;

- Suggestions for the system.

Pilot requirements gathering during its implementation and the studying of the user's requirements are essential for the improvement and adaptation of the TeNDER system interface. By continuous information gathering regarding user requirements throughout each of the pilot waves, it will be possible to achieve a better adaptation to the needs of patients, carers, and professionals, as well as to adapt the system to the users and the real scenarios. To achieve it, the following is explored:

3. **Researcher's impressions during study conduct**. The reactions, feelings, and opinions expressed by the participant during his or her experience using the TeNDER system will provide important information about the usability requirements that need to be taken into account. For this purpose, in person or by telephone through regular user interviews, the following are explored:
   - First reactions of the user;
   - First barriers (within first days);
   - Barriers of usage (within weeks);
   - Special feedbacks;
   - Complaints;
   - Observations at the end of testing.

Using this information, a SWOT analysis [1] will be carried out to provide a realistic, fact-based, and data-driven view of the strengths and weaknesses of the system used in real-world conditions in each of the pilot waves. By examining the Strength, Weaknesses, Opportunities, and Threats based on whether they originate from the user (internal origin) or the system (external origin), everything that will improve the chances of success can be explored.

Table 3 - SWOT Analysis.

Patients	Positive Aspects	Negative Aspects
Internal origin	STRENGTHS	WEAKNESSES
External origin	OPPORTUNITIES	THREATS

Post-pilot requirements gathering:

4. **Final open questions.** To improve the TeNDER system interface for the next waves of piloting, it is necessary to explore the user requirements after the end of the experience, with all of the participants. To do this, positive and negative aspects, as well as feelings aroused using the technology, will be explored. This is enabled by asking three open-ended questions to the involved participants (I.e., patients, caregivers, and professionals):
   1. How do you feel with TeNDER sensors?

2. What do you like less about TeNDER sensors?
3. What do you like more about TeNDER sensors?

2.2 Development sprint and codesign

To address the user-friendly approach, the first developed mock-ups, based on the documentation in WP2 (co-design) and WP3 (Multi-sensorial and affective computing monitoring services), were presented firstly to partners within the project for the co-design process. The first mock-ups were also tested together with the users between December 2020 and January 2021. User partners collected feedback from the potential end-users regarding the generated mock-ups for patients, caregivers, and professionals in an anonymous way, reflected, annotated the information according to their professional experiences, and reported feedbacks and findings in a dedicated document (User requirement Mock-Ups and App). Most mock-ups were presented on a paper version with print screens, while the remaining ones were tested in an app version with the potential end-users.

After the revision by technical partners and based on the collected feedback, an improved version of the mock-ups was created. The revised interface versions (second mock-ups) for all end-user groups were tested in February 2021. The interface for patients and carers was presented and discussed together with user partners and the technical partners responsible for the interface development. The interface for the professionals was developed separately, while the feedback collected and comments were passed through the excel spreadsheet with annotations from technical partners responsible for the Web-App development.

As described in Deliverable 2.4, the pilot partners' researchers also asked patients, caregivers, and professionals several questions about the impression, opinion on user-friendliness, and opinions about specific sections presented while showing them the draft versions (second mock-ups) of the TeNDER interface. Partners also collected feedback from end-users regarding their acceptance to use the App. Feedback addressed data protection issues for the patients' registration process, the layout of the contents, and mainly the high complexity of the UI. The collected feedback from all three participant groups was described and assessed in an internal Task-4 document, whereby the summary was presented in Deliverable 2.4.

Moreover, according to the co-design process, the documentation in WP03 and WP05 was continuously updated, to assure that the end-user's needs are being included in the design process.

2.3 Translation

The TeNDER app currently supports the following five (5) languages:

- English;
- Italian;
- German;
- Spanish;
- Slovenian.

Translations are provided not just for the app's UI (User Interface) titles and descriptions but also for most of the content used in the backend. More specifically, translations were provided and reviewed by all TeNDER partners through a spreadsheet that was then processed and translated into a JSON file (JavaScript Object Notation). Users will, however, see the screens in the language set on their devices without having to select the language in

the APP. We have chosen to use the personal settings of the individual device, avoiding asking the user to choose their language in the setting screens.

2.4 Firebase analytics

Google's Firebase [2] is a Backend-as-a-Service (Baas) and a cloud platform for the development of web and mobile applications.
It is available for different platforms (iOS, Android, and web) and provides a series of utilities that make it possible to work more efficiently. Firebase Analytics is an analytics tool for applications and allows you to manage the development, stability, analytics, and growth of apps.

The information is provided by two types of events:
- Basic or general events that are automatically collected without the need to implement code in the application.
- Custom or specific events that do not come by default and must be implemented by code in the application.

In our case, it is specifically used to track user activities and to receive push notifications into the TeNDER App. Additionally, these events can be enriched with parameters that provide additional information. This information makes it possible to segment the data to gain a deeper understanding of the use of the application by users, the evolution of the event over time, its geographical distribution, etc. As an example, Figures 1, 2, 3 below display the tab-selection event that shows the use of the application in the different functionalities.

Figure 1 below presents the "Active Users" data, which contains a graph of the number of tracking users who were actively using the app in periods of 1, 7, and 30 days (during the first pilot).

Figure 1 - Active users (Firebase Analytics).

The user engagement data, reported in the figure below, compare the following engagement statistics between the specified date ranges:
- Daily engagement – The total amount of time spent by users engaging with the app;
- Daily engagement per user – The average duration of engagement per user;
- Sessions per user – The total number of sessions divided by the total number of active users;
- User engagement per screen – An analysis of the user engagement time on a per-screen basis within the app.

In each graph in this figure, the solid line means the selected date range, and the dotted line is the comparison date range. The percentage value indicates the amount by which each of the engagement metrics has changed between the two ranges.

Figure 2 - Daily user engagement (Firebase Analytics).

Figure 3 below refers to users in TeNDER who started using the app within the same time. In a nutshell, this figure shows the retention for each cohort, in other words, the percentage of users within each cohort who continued to use the app within subsequent weeks. Rows in the graph represent a cohort and each block in the row has a percentage value indicating the retention rate for that group of users. The rule to be considered is "the darker the shading of the block, the higher the retention rate".
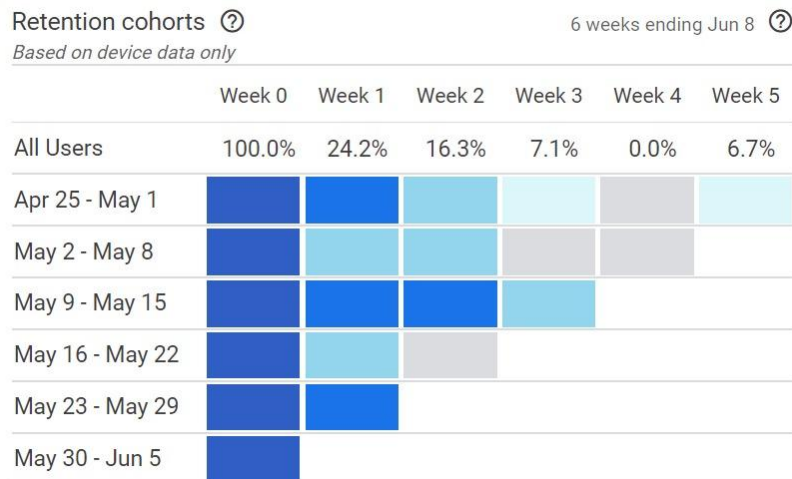

Figure 3 - Retention cohorts (Firebase Analytics).

3. INTERACTION WITH BACKEND

One of the main tasks of the TeNDER platform is to implement the necessary conditions to ensure adherence to the European regulations for data accessing and processing via Electronic Health Records (EHR) systems. According to this requirement, a state-of-the-art EHR was deployed, based on an open-source implementation called HAPI FHIR (Fast Healthcare Interoperability Resources) [3] which provides a RESTful API compatible with the HL7 standards [4]. The HL7 standards provide a framework for exchanging, integrating, sharing, and retrieving electronic health information. These standards define how data is packaged and communicated from one party to another, setting the language, structure, and data types required for seamless integration between systems. HL7 standards support clinical practice and the management, delivery, and evaluation of health services, being recognized as the most used in the world. In the first version of the TeNDER platform the above-mentioned RESTful API provides an easy way for interoperability with external EHR systems and, at the same time, is consumed by the Web and Hybrid mobile applications, which are the interfaces between the platform and the users.

Since the detailed description of the EHR server is already available in Deliverable D5.3, this section's focus will be on the EHR API as a Northbound interface of the TeNDER platform and how it is used by Web and Hybrid mobile applications.

In TeNDER architecture, the EHR server has integrated an Authorization and Authentication server named Keycloak, an open-source identity and access management solution [5]. It provides SSO (Single sign-on) service – uses the same credentials to authenticate in several applications - to ensure end-to-end secure communication between the platform's HTTPS proxy server and the public network. Because of Keycloak's architecture and structure, the TeNDER platform can provide multitenancy, authorized and secure data access based on specific user roles. For that, users must have specific attributes and roles, which gives them the proper permissions. For instance, a user registered as a patient will have the role 'patient' and attributes like its organization, environment (and others). The administrator will have other roles and attributes which let him access only his organization's users and remaining data. All of this optimizes the system workflow and Keycloak's correct management.

The following tables expose the attributes and roles used until now on Keycloak.

Table 4 - User Attributes.

User Attributes	Description
user_id	User's internal identifier
organization_id	User's organization identifier
group_id	Control/Intervention Group's identifier
environment	A list of the patient's environments
eusurveyId	EuSurvey's user identifier
codeUser	Unique anonymized code for user's identification
username	User's username

roles	A list of the user's roles

Table 5 - User Roles.

User Roles	Description
doctor	Role for health professionals
patient	Role for patients
family_member	Role for family members
formal_caregiver	Role for formal caregivers
informal_caregiver	Role for informal caregivers
social_professional	Role for social professionals
other_professional	Role for other professionals
social_worker	Role for social workers
tender-admin	Role for TeNDER's management
organization-admin	Role for organization's management

The management of the rest entities (i.e., disease, devices, measurements, events, etc.) and the correlation with specific patients are handled inside the EHR server [6].

The main components of the EHR server are:

- **Resource Providers:** A RESTful server Resource Provider is provided for each resource type which implements a Search method implementing the complete set of search parameters defined in the FHIR specification for the given resource type. The resource providers also support other FHIR methods, such as Read, Create, Delete, etc. The resource providers do not actually implement any of the logic in searching, updating, etc. They simply receive the incoming HTTP calls (via the RestfulServer) and pass along the incoming requests to the DAOs.
- **DAOs:** The DAOs actually implement all of the database logic relating to the storage, indexing, and retrieval of FHIR resources, using the underlying JPA API.
- **Hibernate:** The HAPI JPA Server uses the JPA library, implemented by Hibernate.
- **Database:** The RESTful server uses postgres database but can be configured to talk to any database supported by Hibernate.
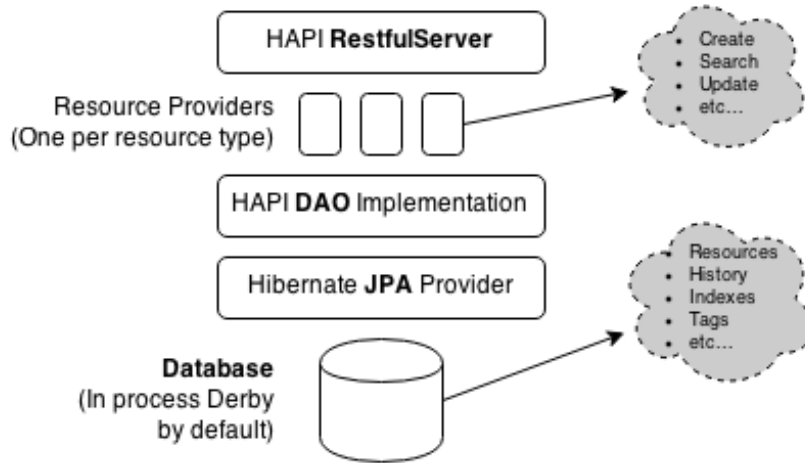
Figure 4 - HAPI FHIR JPA architecture

3.1 Workflow

The resources of the TeNDER EHR are accessible from external authenticated client applications based on access tokens provided from Keycloak. The exact data flow is shown in the following sequence diagram (Figure 5).
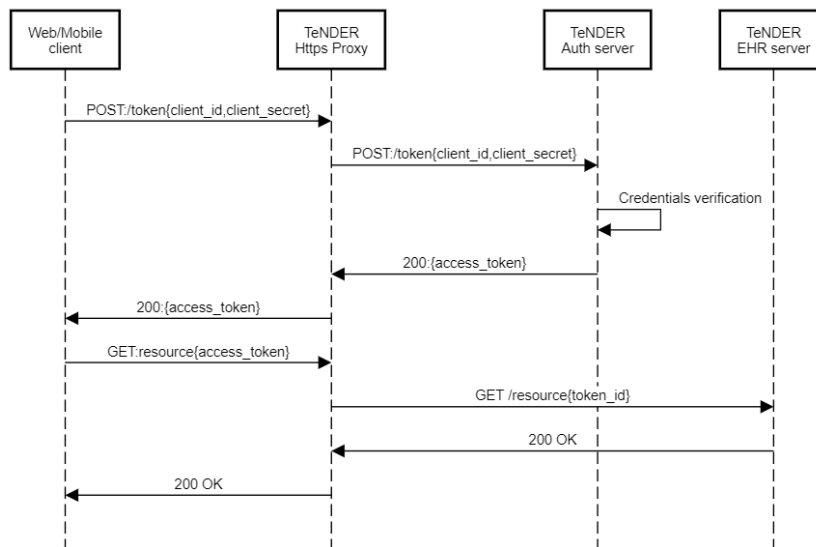

Figure 5 - TeNDER EHR sequence diagram.

As a reference example of the northbound interface, we describe the actions that are necessary in order to create a new organization, a new patient (under the organization) and an observation, based on device measurements. The exact sequence that should be followed is:

1. Get access token
    Command:

    ```
    curl -k --data "grant_type=password&client_id=hapifhir-
    server&client_secret=<cnt_secret>&username=<usr>&password=<pass>" \
    https://auth-stage-
    tender.maggiolicloud.it/auth/realms/TeNDER/protocol/openid-connect/token
    ```

    Response:

```
{
    "access_token": "eyJhb88h…1mpg",
    "expires_in": 300,
    "not-before-policy": 0,
    "refresh_expires_in": 1800,
    "refresh_token": "eyJhbfl…DpXvE",
    "scope": "api-db email profile",
    "session_state": "a841147e-63a1-42f4-9d12-56578c372fea",
    "token_type": "bearer"
}
```

2. Create Organization

Command:

```
curl -k -X POST https://fhir-stage-tender.maggiolicloud.it/hapi-fhir-
jpaserver/fhir/Organization?_format=json&_pretty=true\
-H "accept: application/json" -H "Content-Type: application/json" \
-H "Authorization: Bearer <access_token>" \
-d "{
  "resourceType": "Organization",
  "active": true,
  "type": ["Daycare center"],
  "name": "organazation1",
  "alias": ["my_org"],
  "telecom": ["web"],
  "address": ["Long street 10"],
  "contact": [{
    "purpose": "Director",
    "name": "John Smith" ,
    "telecom": ["js@mail.com"],
    "address": "Long Street 100"
  }],
  "endpoint": ["none"]}"
```

Response:

```
{
  "resourceType": "Organization",
  "id": "1",
  "meta": {
    "versionId": "1",
    "lastUpdated": "2020-07-20T13:51:53.982+00:00"
  },
  "active": true,
  "name": "organazation1",
  "alias": [ "my_org" ]
}
```

3. <u>Create User</u>
   Command:

```
curl -k -X POST https:// fhir-stage-tender.maggiolicloud.it/hapi-fhir-
jpaserver/fhir/Patient?_format=json&_pretty=true\
-H "accept: application/json" -H "Content-Type: application/json" \
-H "Authorization: Bearer <access_token>" \
-d "{
  "resourceType" : "Patient",
  "active" : true,
  "name" : ["Alice Parker"],
  "telecom" : [{"moblie":"123456789"}],
  "gender" : "female",
  "birthDate" : "1013-01-14",
  "deceasedBoolean" : false,
  "address" : ["Short Street 1"],
  "maritalStatus" :"false",
  "photo" : ["None"],
  "contact" : [{
    "relationship" : ["parent"],
    "name" : "Mummy",
    "telecom" : ["email"],
    "address" : "Middle length Street 50",
    "gender" : "female"
  }],
  "generalPractitioner" : ["None"],
  "managingOrganization" : {"reference": "Organization/1"}
}"
```

Response:

```
{
  "resourceType": "Patient",
  "id": "3",
  "meta": {
    "versionId": "1",
    "lastUpdated": "2020-07-20T14:59:18.256+00:00"
  },
  "text": {
    "status": "generated",
    "div": "<div xmlns=\"http://www.w3.org/1999/xhtml\"><div
class=\"hapiHeaderText\"/><table
class=\"hapiPropertyTable\"><tbody><tr><td>Address</td><td/></tr><tr><td>
Date of birth</td><td><span>14 January
1013</span></td></tr></tbody></table></div>"
  },
  "active": true,
  "gender": "female",
  "birthDate": "1013-01-14",
  "deceasedBoolean": false,
  "contact": [ {
    "gender": "female"
  } ],
  "managingOrganization": {
    "reference": "Organization/1"
  }
}
```

4. Create Observation
   Command:

```
curl -k -X POST https:// fhir-stage-tender.maggiolicloud.it/hapi-fhir-
jpaserver/fhir/Patient?_format=json&_pretty=true\
-H "accept: application/json" -H "Content-Type: application/json" \
-H "Authorization: Bearer <access_token>" \
-d " {
    "resourceType":"Observation",
    "identifier":[
        {
            "use":"official",

"system":"http://www.bmc.nl/zorgportal/identifiers/observations",
            "value":"6323"
        }
    ],
    "status":"final",
    "code":{
        "coding":[
            {
                "system":"http://loinc.org",
                "code":"15074-8",
                "display":"Glucose [Moles/volume] in Blood"
            }
        ]
    },
    "subject":{
        "reference":"Patient/3"
    },
    "effectivePeriod":{
        "start":"2021-04-02T09:30:10+01:00"
    },
    "issued":"2021-04-03T15:30:10+01:00",
    "valueQuantity":{
        "value":6.3,
        "unit":"mmol/l",
        "system":"http://unitsofmeasure.org",
        "code":"mmol/L"
    },
    "interpretation":[
        {"coding":[{
                "system":"http://terminology.hl7.org/CodeSystem/v3-
ObservationInterpretation",
                "code":"H",
                "display":"High"}]}],
    "referenceRange":[{
        "low":{
            "value":3.1,
            "unit":"mmol/l",
            "system":"http://unitsofmeasure.org",
            "code":"mmol/L"
        },
        "high":{
            "value":6.2,
            "unit":"mmol/l",
            "system":"http://unitsofmeasure.org",
            "code":"mmol/L"
}}]}
```

Response:

```json
{
  "resourceType": "Observation",
  "id": "5",
  "meta": {
    "versionId": "1",
    "lastUpdated": "2020-07-20T15:09:06.709+00:00"
  },
  "identifier": [ {
    "use": "official",
    "system": "http://www.bmc.nl/zorgportal/identifiers/observations",
    "value": "6323"
  } ],
  "status": "final",
  "code": {
    "coding": [ {
      "system": "http://loinc.org",
      "code": "15074-8",
      "display": "Glucose [Moles/volume] in Blood"
    } ]
  },
  "subject": {
    "reference": "Patient/3"
  },
  "effectivePeriod": {
    "start": "2021-04-02T09:30:10+01:00"
  },
  "issued": "2021-04-03T15:30:10+01:00",
  "valueQuantity": {
    "value": 6.3,
    "unit": "mmol/l",
    "system": "http://unitsofmeasure.org",
    "code": "mmol/L"
  },
  "interpretation": [ {
    "coding": [ {
      "system": "http://terminology.hl7.org/CodeSystem/v3-
ObservationInterpretation",
      "code": "H",
      "display": "High"
    } ]}],
  "referenceRange": [ {
    "low": {
      "value": 3.1,
      "unit": "mmol/l",
      "system": "http://unitsofmeasure.org",
      "code": "mmol/L"
    },
    "high": {
      "value": 6.2,
      "unit": "mmol/l",
      "system": "http://unitsofmeasure.org",
      "code": "mmol/L"
}}]}
```

4. FRONT-END LAYERS COMPOSITION

As mentioned above, there are three different interfaces foreseen within TeNDER: (1) Web platform (Health professional-oriented); (2) Mobile interface for caregivers and patients; (3) Tablet (patients oriented). In this section the front-end layers composition, presenting the description of the technical features of the TeNDER Web Platform and Mobile app with paragraphs focused on the description of the available functionality and screens is reported.

4.1 Technical features of the web platform

As part of initial requirements, there was the need to develop a solution that provides an efficient and interactive way for the health professionals to have their private area for their patient's management.

After some research, the development of a web application was the best option. It provides a lot of space to present information which gives several possibilities for its organization and visualization (dashboard view, charts, etc.).

Before the health professionals interface development, some mock-ups were built to properly define its components, design, and exposed information (check Annex A). It used a colour palette and specific icons that were confirmed and validated by the end-users' partners. The mock-ups provided don't cover all the functionalities developed but gave help to follow a pattern with the general structure and design.

For its development, due to already acquired experience in some programming languages, it used a JavaScript library React [7] with a production-grade state management framework called Kea [8]. For more detailed information, check the following table (table 6).

Table 6 - Technologies and Frameworks.

Webapp built	React.js JavaScript Framework with Kea (state management)	
Styling / CSS	Styled Components Plugin	
API's Communication	Axios Library [9]	
Other React / JavaScript packages and libraries	lodash [10]	Data Formatting and manipulation utilities
	chart.js [11]	Chart rendering
	element-ui [12]	Several form / interactive components
	react-beautiful-dnd [13]	Drag & Drop functionalities
	react-i18n-next [14]	Dynamic loading of translation / localization strings

During the development of the health professionals' interface, a new mandatory requirement was raised. For the efficient management of all organizations, patients, and devices, a new interface was needed, just for the organizations' administrators. It led us to the need of two different interfaces – one for the health professionals and another for the administrators – which interface appears would depend on the users' role who successfully logged in.

For the administrators' interface, there weren't any mock-ups. The reason falls on the timing of the decision of its inclusion as a new interface in the web app. Due to it, the developers followed the pattern already implemented in the health professional's interface and reused its components for fast development and better comprehension and efficiency. Since this interface is just for management purposes, the main goal was to provide all the needed functionalities with good usability and comprehension at the time for the first wave.

The following tables (table 7 and 8) present the supported browsers and technical requirements for an efficient and pleasant use of the webapp.

Table 7 - Supported Browsers.

Supported Browsers	Exceptions
All desktop web browsers with JavaScript support (Internet Explorer, Firefox, Chrome, and Opera).	Some CSS anomalies may happen on mobile devices or older browsers (such as Internet Explorer 9 and below) without HTML5 / CSS3 support

Table 8 - Technical Requirements.

Components	Requirements
Internet browser	HTML / CSS rendering and a JavaScript engine
Internet connection	Consistent connection
RAM	At least 1GB RAM
Layout	Minimum 1280 x 720

4.2 Technical features of the TeNDER App

The application is designed to support patients and secondary users. The requirements arose to develop interfaces for users who are not digitally active. Based on this assumption, a hybrid app was developed, using the Ionic Framework, allowing greater flexibility and adaptability in the development process. For the design and interfaces, a specific colour palette and icons were used in compliance with the accessibility requirements: the style guide is attached (see Annex B).

The technical features of the mobile app are shown in the tables below.

Table 9 - Technologies and Frameworks.

Mobile app built	Ionic 5 [15]	
API's Communication	HAPI FHIR integration	
Additional features	Firebase [2]	Firebase integration for push notifications
	Firebase Analytics [2]	Firebase integration for analytics tracking

The table below lists the operating systems supported by our solution.

Table 10 - Supported Operating System.

Operating system supported	Exceptions
Android 8+ (API level 26)	On tablets, some UI adaptation issues may occur.
iOS (11+)	On tablets, some UI adaptation issues may occur.

The following table lists the supported devices and the characteristics they must fulfil.

Table 11 - Technical Requirements.

Supported devices	Requirements
Smartphones	Minimum 5" display Wi-Fi or LTE connectivity Google Play Services availability
Tablets	Minimum 9.7" display Wi-Fi or LTE connectivity Google Play Services availability

Although the current solutions support both operating systems mentioned in the previous table, it is important to mention that for logistical and speed reasons the solution was distributed in the form of an APK (Android Application Package), avoiding asking users to download the app from the various dedicated marketplaces.

4.3 Compliance with accessibility standards

TeNDER App is designed and developed considering the lack of capacity of older people to use technology and, therefore, the compliance with the accessibility standard.

All the co-design processes of the App paid a particular focus on the simplicity of interfaces/functionality, releasing a solution with simple screens, with few components per layout. One of the main features in terms of visual accessibility of the App is the Dark Mode, namely the dark screen version that can be activated from the App in the settings section Dark theme (see Figure 6).

This feature has many benefits:

- Improves visibility for TeNDER users with low vision and those who are sensitive to bright light;
- Makes it easier for anyone to use a device in a low-light environment.

Moreover, this function reduces power usage by a significant amount (depending on the device's screen technology).
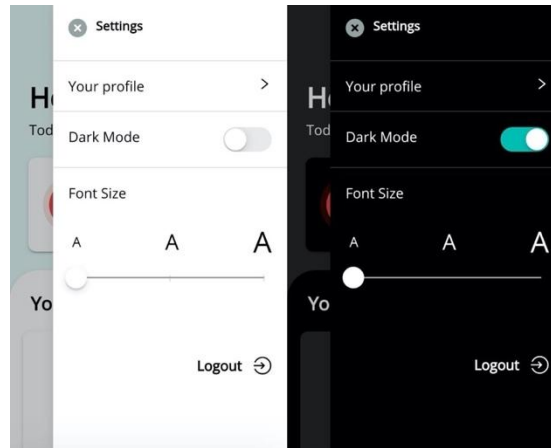
Figure 6 - Setting dark mode.

To cope with visual impairments, users can set appropriate text size in the section settings, which are among 16-18px for higher resolution (see Figure 7).
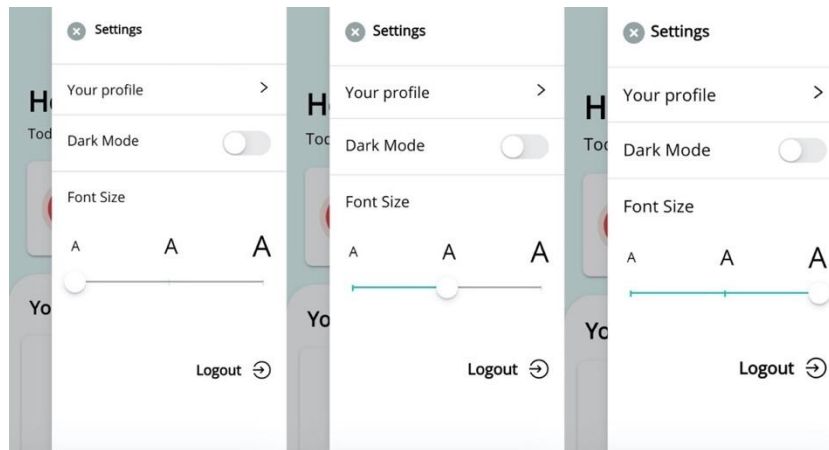
Figure 7 - Setting text size.

During the design phase, the production of a style guide has encouraged consistency in the visual identity and helped keep the system interfaces as logical as possible, which makes for a better UX. The style guide in annex B demonstrates how all interface elements and components are visually represented. It's essentially a master reference for the user interface (UI). As can be seen from section b in Annex B, the app passed all accessibility tests and achieved a VGA grade of AAA.

4.4 Functionality and screens of the TeNDER web platform

After the development of the web application for the TeNDER project, two interfaces were made. Each one has its functionalities and screens as to not have unnecessary and/or unauthorized functionalities in the wrong interface.

4.4.1 Functionalities of the TeNDER web platform

As mentioned, the web app has two different interfaces for two kinds of users: the organization's administrators and health professionals. Although some functionalities are

standard, most of them are specific for each interface, which highly improves the user's interaction and management and, at the same time, the system's security, and organization.

4.4.1.1 Standard Functionalities

The following table (table 12) presents an overview of all standard functionalities.

Table 12 - Description of the Standard Functionalities.

Functionality	Description
Login	In order to access his private area, each user must go through a login process, which is the same for all.
Logout	When a user wants to logout, the process is always the same.
Change the language	All users can change the default language to one of the available (English, German, Slovenian, Spanish, and Italian).
Show user's username and role	Having access to his private area, every user has access to his username and role.

4.4.1.2 Administrator's Interface

The following table (table 13) presents an overview of the functionalities integrated only in the administrator's interface.

Table 13 - Description of the Administrator's Functionalities.

Resource	Functionality	Description
Devices	(De)activate Device	Deactivate or activate a device.
	Create device	Possibility to create a device and associate it with a user in a specific location of the user's environment.
	Delete device	Delete a device.
	Edit device	Edit an existing device.
	Search device	Search for a specific device by its name or serial number.
	View history	View the device's activation and deactivation history, presenting the timespan between them.
Groups	List organization's groups	List the groups available in the organization in a dropdown menu, in order to be able to choose one.
	List group's members	Having chosen one of the available groups, its

		members are listed with a background colour to indicate if they are activated or not.
Users	(De)activate user	Deactivate or activate a user.
	Create user	Create a user where, depending on the selected role, a specific form is displayed. The administrator must fill at least the mandatory fields, or the creation fails.
	Delete user	Delete a user.
	Edit user	Edit an existing user. It includes his comorbidities, research experience's observations and group.
	Filter users	Filter the user's list by role or, in case of patients, by main diseases.
	List users	List all the organization's users, organized by role.
	List user's devices	List the user's devices.
	List user's informal caregivers and family members	List the user's informal caregivers and family members. They can be edited, (de)activated or deleted.
	Order users	Order the user's list by username.
	Search user	Search for a specific user by username and name.

4.4.1.3 Health Professional's Interface

The following table (table 14) presents an overview and description of the Description of the Health Professional's Functionalities.

Table 14 - Description of the Health Professional's Functionalities.

Components	Functionality	Description
Home	Emergency Notifications	List the emergency notifications from the past seven days. It includes fall,

		cry, and outside notifications.
	Patients List	List the user's last five patients added, where it's possible to select one to see his details or be redirected to another page to see all user's patients.
Patients List	List all user's patients	List all user's patients where it's possible to choose one to see his details.
	Search for patient	Search for a specific patient through his name or username.
	Order user's patients list	Ascending or descending ordering of the list.
Patient Details	Patient Info	Display the patient's general information (name, username, gender, etc).
		List patient's family members and informal caregivers.
	Health Tracking	Display last heartbeat rate received.
		Display heartbeat rate and steps average for a specific day, week, or month.
		List all the events for a specific day, week, or month.
	Reminders	Display a calendar to check all the available reminders.
		Create new reminders.
		List reminders for a specific day and see if they were already read or not.
		View reminder details with the possibility for edit and delete it.
	Sleep Diary	Chart with the accumulated data for each type of sleep measure (deep, light, etc.) for a specific day, week, or month.
		Night's sleep chart for a specific day.

		Display sleep score and heartbeat and respiration rate averages for a specific day, week or month.
		Display duration, sleep depth, and snoring count as additional information.
	Safety and Wellbeing	Display the number of falls and the possibility to list its history for a specific day, week, or month.
		Display the patient's emotional state percentage through sad or happy data and the possibility to list its history for a specific day, week, or month.
		Display the last emotion received and when.
	Localization	Display a chart where, depending on the patient's environment, it's possible to visualize where the patient was and for how much time. The several locations associated with his environment can be chosen and filtered to improve the chart visualization. The search can be done for a specific day, week, or month.
	Survey	Not implemented.
	Social Services Matching	Not implemented.

4.4.2 Screens

The following figures are grouped by interface (except the standard pages) and related with the first pilot's result.

4.4.2.1 Standard Screens
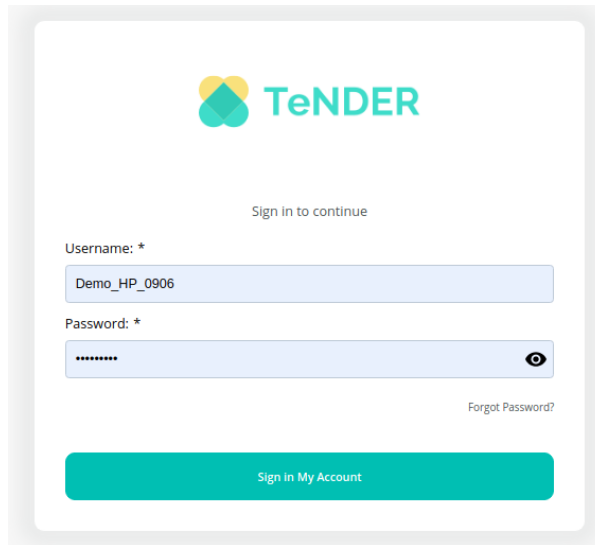
Figure 8 - Login page.

The only standard page in the web app is the login page. Here is where all the users need to fill in their credentials to be able to access their private area.

4.4.2.2 Administrator's Interface

4.4.2.2.1 List Users
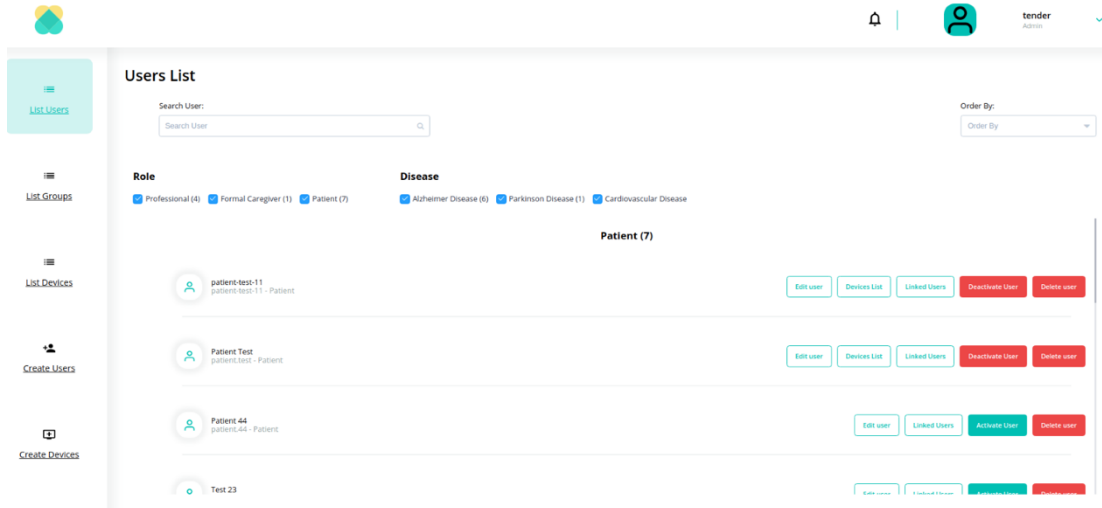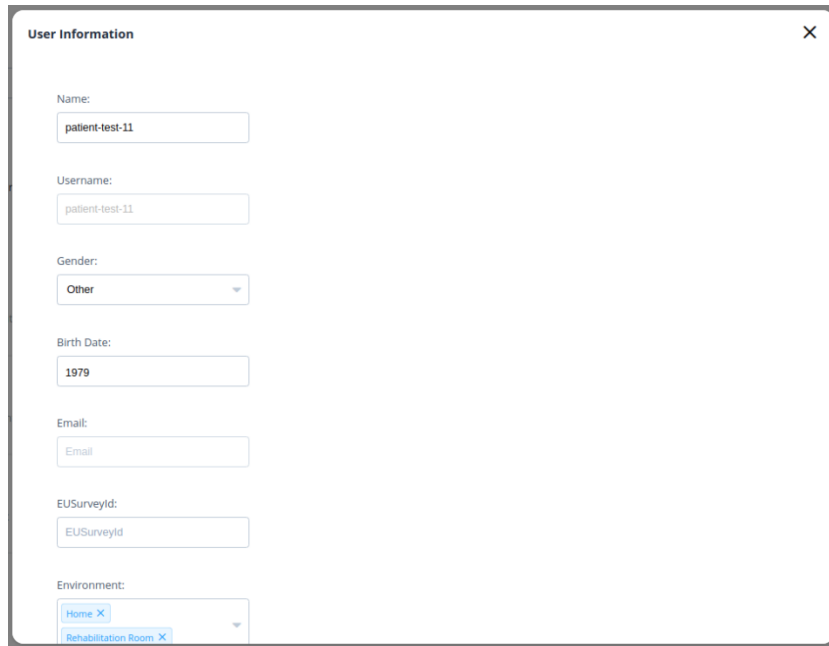
Figure 9 - User list page.

Figure 9 is related to the 'List Users' page. It's the page to which the user is redirected after the login phase. In addition, this page contains several modals where attached information or feedback is shown. The following figures show what is possible to see by clicking on the patient's buttons.
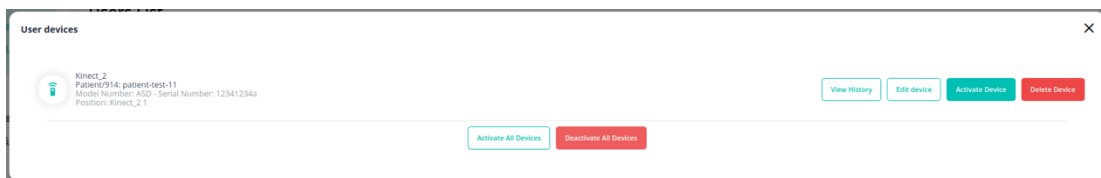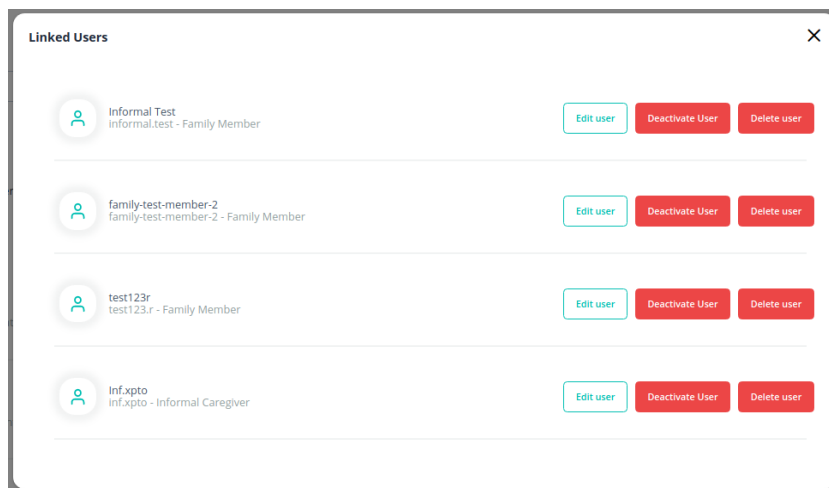
Figure 10 - Edit User's Modal.
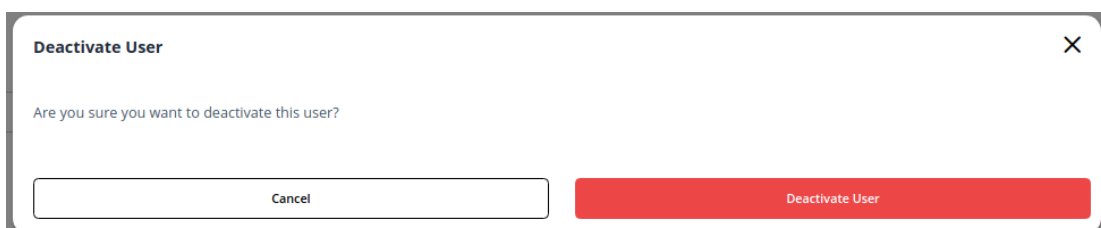
Figure 11 - User's Devices Modal.

Figure 12 - User's Linked Users Modal.

Figure 13 - Deactivate user confirmation feedback.
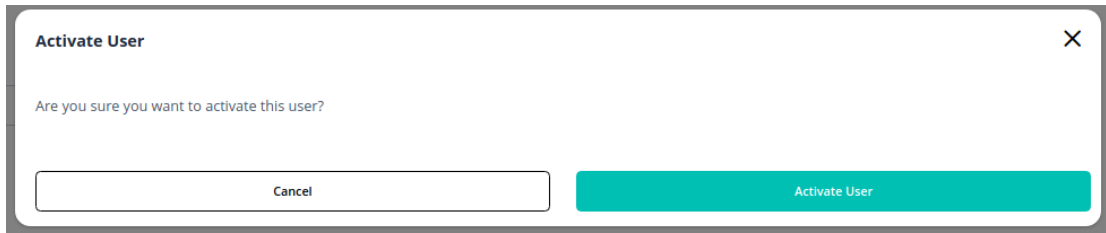
Figure 14 - Activate user confirmation feedback

Figure 15 - Delete user confirmation feedback.

4.4.2.2.2 List Groups
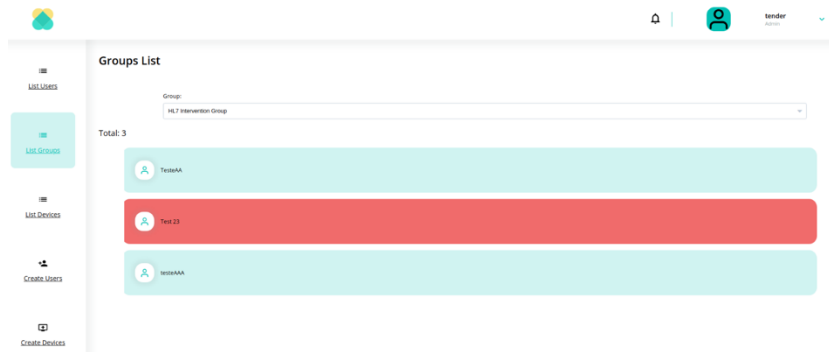
Figure 16 - Group's List Page

In the figure above (Figure 16) a specific group was already chosen, and the members have been displayed. From the colour's feedback, two users are active, and the remaining are not.

4.4.2.2.3 List Devices
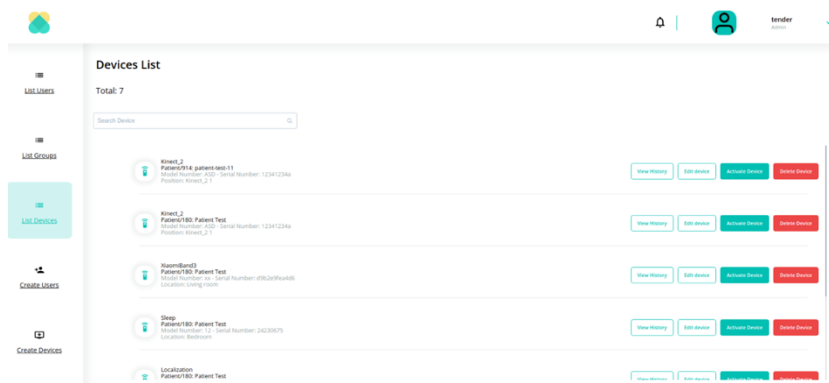
Figure 17 - Device's List Page.

In figure 17, a list of all the organization's devices is shown. They can be filtered through the search bar and, on each device, it's possible to do specific actions. The screens from those actions are the following:

Figure 18 - Device's History Modal.

Figure 19 - Edit Device Modal.

Figure 20 - Device's Activation Modal.

Figure 21 - Device's Deactivation Modal.

4.4.2.2.4 Create User
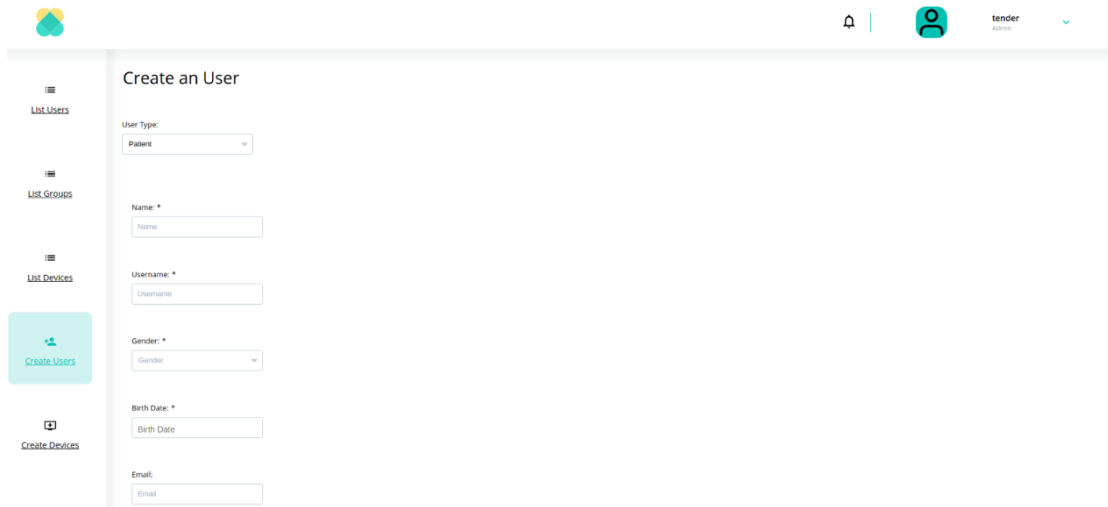
Figure 22 - User's Creation Page.

Figure 22 is related to the creation of a user, more precisely, a patient. Each user has its form, depending on its type. The fields with '*' are mandatory. If they are not in compliance with the request or are empty, an alert is shown and a message ("Mandatory field") it's exposed in the wrong field (Figure 23).
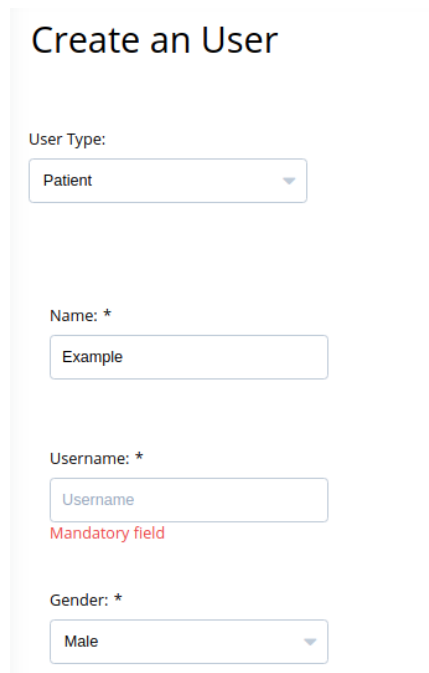
Figure 23 - User's Creation feedback message.

4.4.2.2.5 Create Device
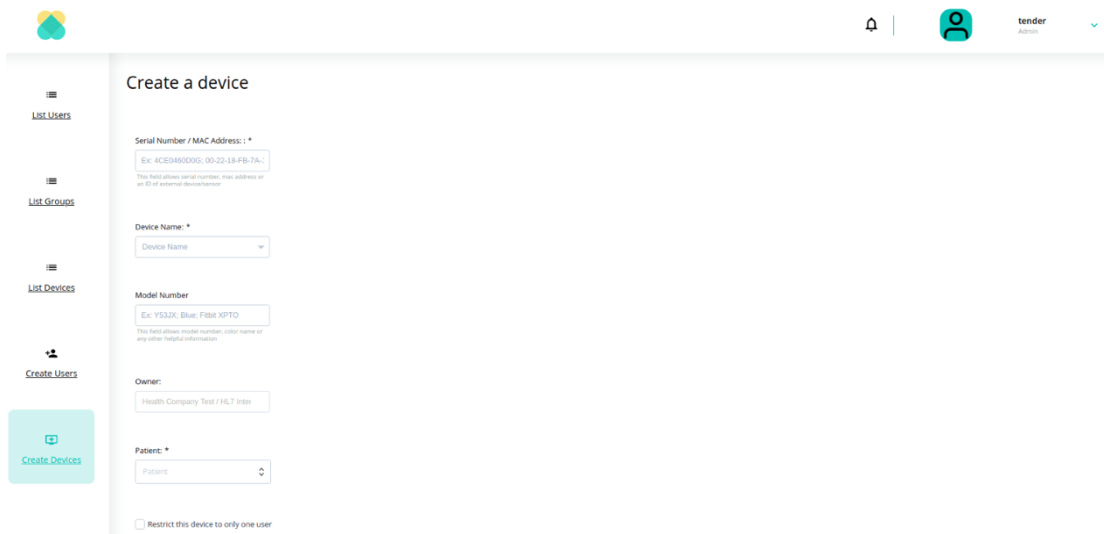
Figure 24 - Device's Creation Page.

Similarly, to 'Create User page', a form is generated where the user needs to fill at least the mandatory fields. For this case, the form is always the same for any kind of device.

4.4.2.3 Health Professional's Interface

4.4.2.3.1 Home
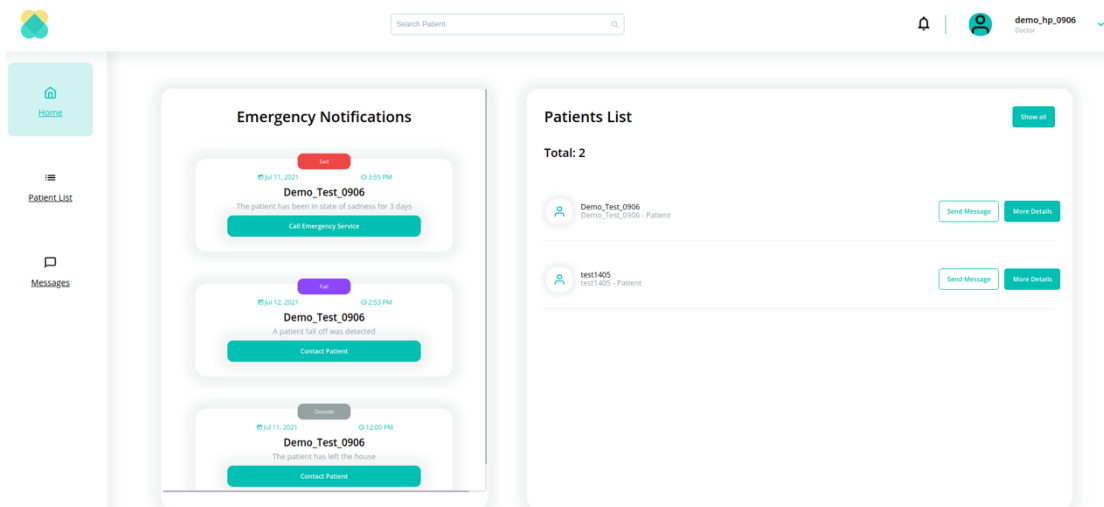
Figure 25 - Main Page.

After the login, the user is redirected to this page (Figure 25). It has two main components: the emergency notifications from the past seven days and the last five patients inserted and associated with the user.

Besides that, it's possible to visualize both the lateral bar with three main buttons (Home, Patient List, and Messages) and the search bar to look for a specific patient. By searching there, the dropdown menu gives the available options (patients) where the user, by choosing one, is automatically redirected to the patient's detail page.

4.4.2.3.2 Patient List
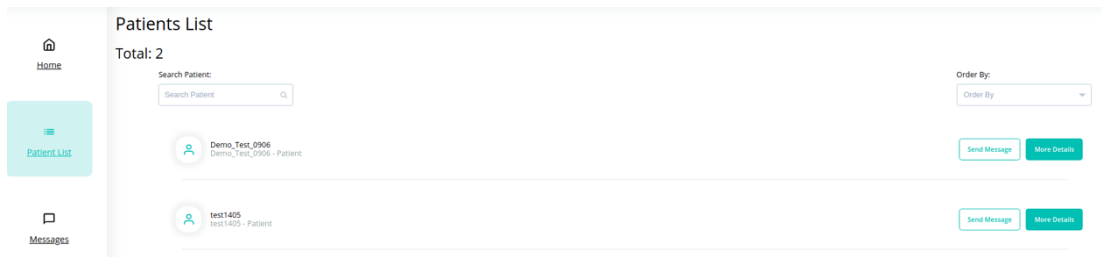
Figure 26 - Patient's List Page.

This list of patients is related only to the health professional's patients. It's a general way to list all the patients on a particular page. The search, ordering, and redirection to the patient's detail page are equally possible.

4.4.2.3.3 Patient's Details (Patient Info)
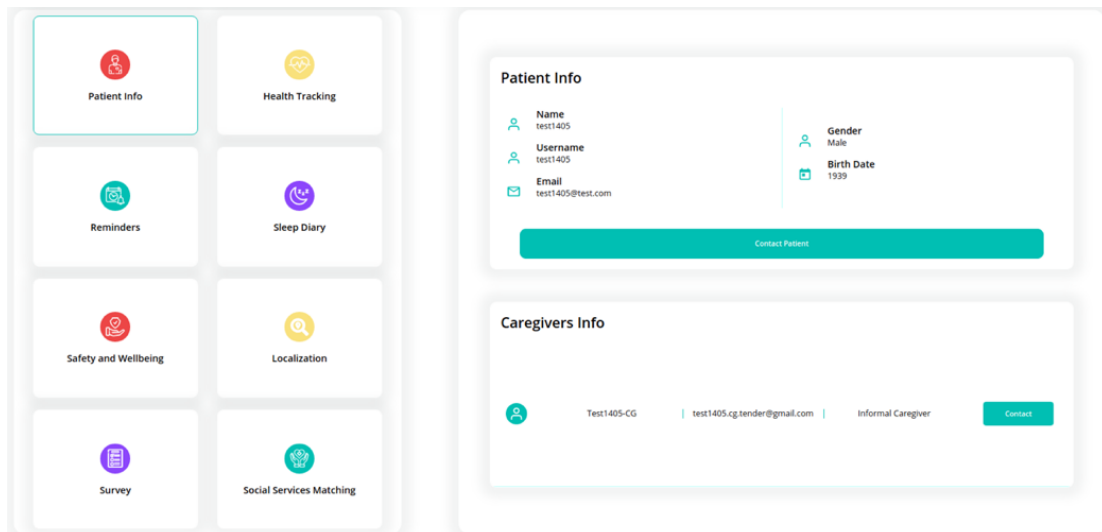
Figure 27 - Patient's Details Page (Patient Info).

When the user is redirected to the patient's details page, the first component to be shown is the 'Patient Info'. In figure 27, the patient has one informal caregiver, and the health professional can also see the patient's general information.

4.4.2.3.4 Patient's Details (Health Tracking)
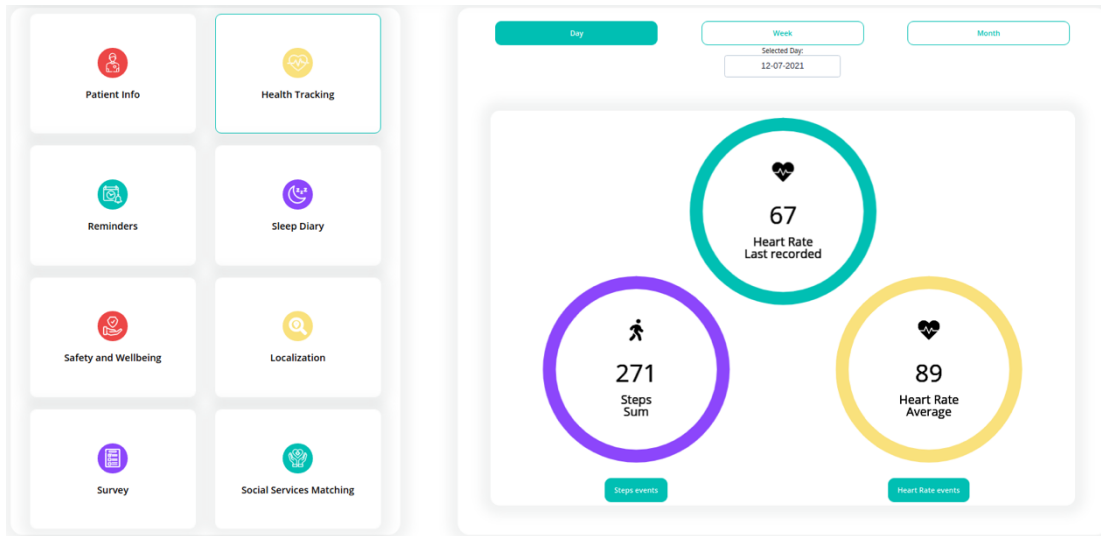
Figure 28 - Heartbeat rate and steps data.

In the 'Health Tracking' component, if the search is for the actual day, the last recorded heartbeat rate is displayed. Otherwise, only the averages are shown. By clicking on one of the events buttons, the history is shown in a modal (Figure 29).
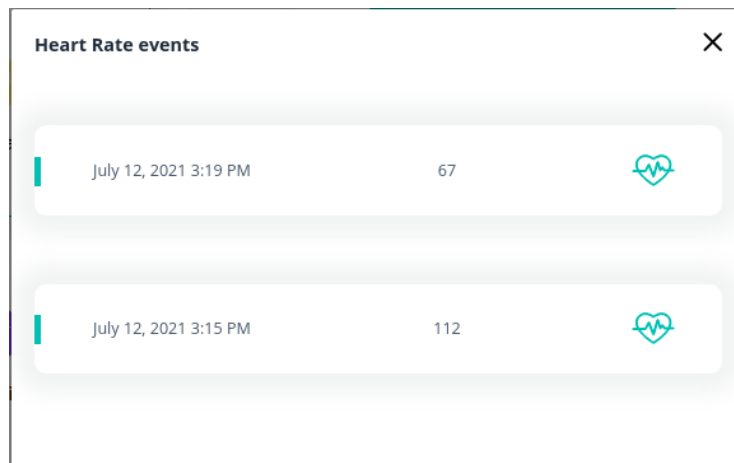
Figure 29 - Heartbeat rate history (Health tracking).
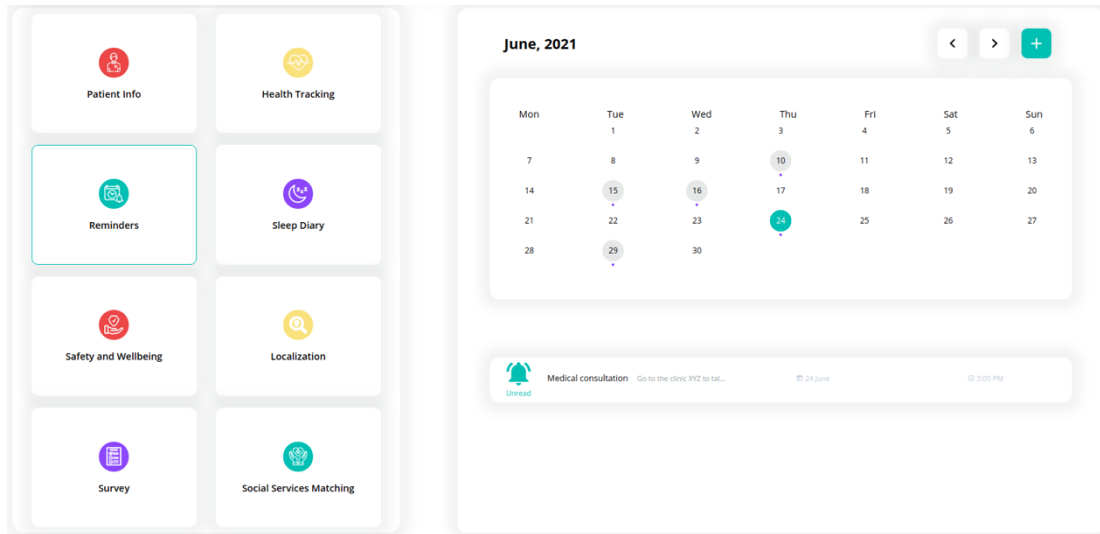
4.4.2.3.5 Patient's Details (Reminders)

Figure 30 - Reminder's List (Calendar).

For the Reminders component, its organization is made through the use of a calendar. The reminders exist in the days marked with a small circle below, which can be selected to list its reminders. Each reminder presented can have the state 'unread' or 'read', depending on if the patient already saw the reminder. Additionally, by clicking on a reminder, a modal is displayed with all the data associated with the option of edit or delete (Figure 31).
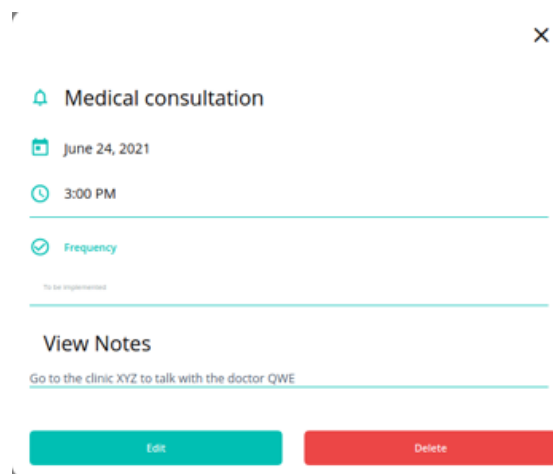
Figure 31 - Reminder's Details.

To create new reminders, it's necessary to click on the icon '+'. By doing it, a form is displayed, via modal. There are, again, mandatory fields that need to be filled to successfully create a reminder (Figure 32).
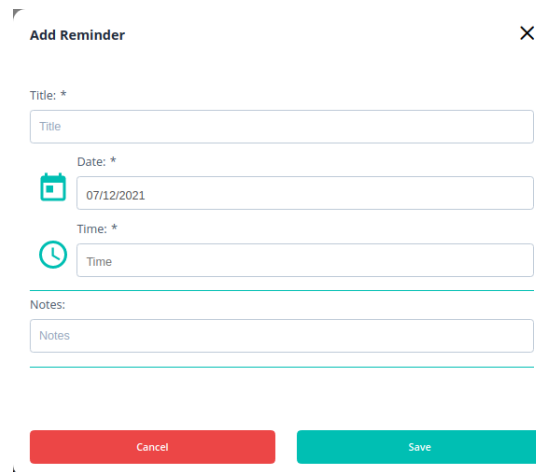
Figure 32 - Create Reminder's Form.

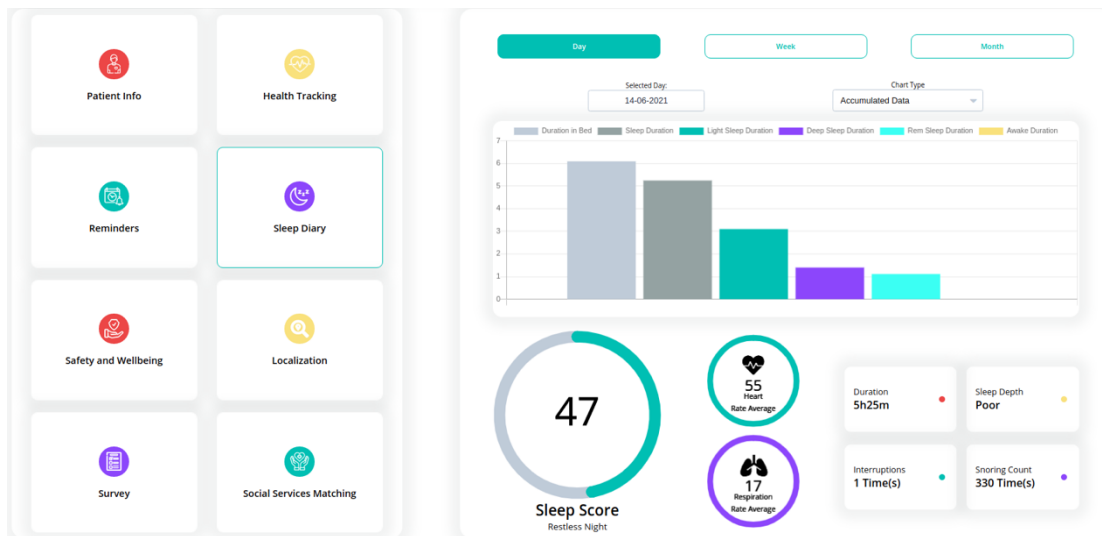#### 4.4.2.3.6 Patient's Details (Sleep Diary)

Figure 33 - Sleep Diary's Standard View.

In figure 33, the standard view for the sleep diary component is exposed. The standard chart is the 'Accumulated Data'. All the possible types are listed in the chart where the accumulated time can be checked. This chart is used for all types of searches (day, week, and month). There is another chart called 'Night's Sleep', which works only for the search of a specific day and presents the sleep quality more detailed (Figure 34).
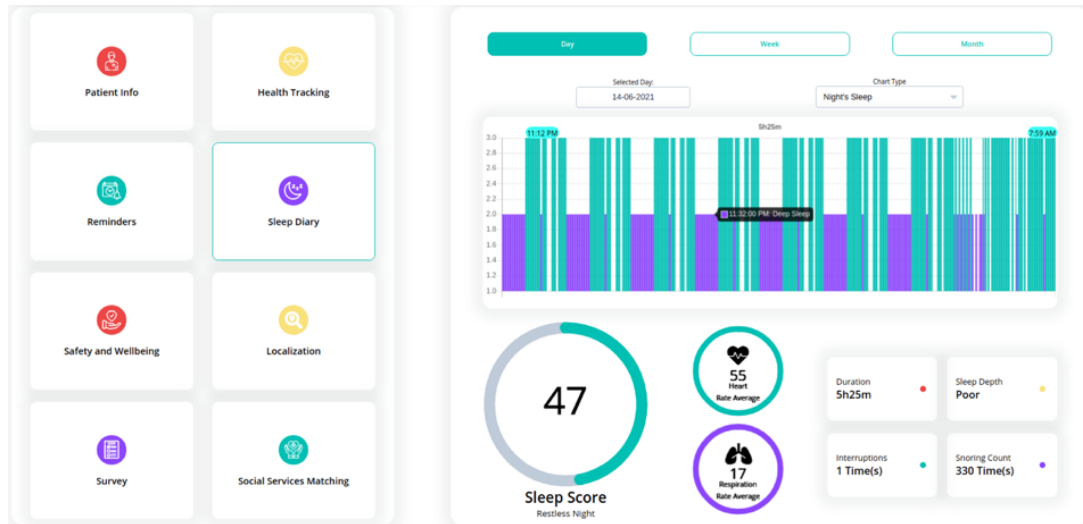
Figure 34 - Sleep Diary's Standard View with night sleep chart.

The remaining data, present in two different ways, is related to important sleep status.

4.4.2.3.7 Patient's Details (Safety and Wellbeing)

The safety and wellbeing component has two main features: fall (Figure 35) and emotional state (Figure 36) detection. Both have the search through the day, week, month, and the possibility to see its history.
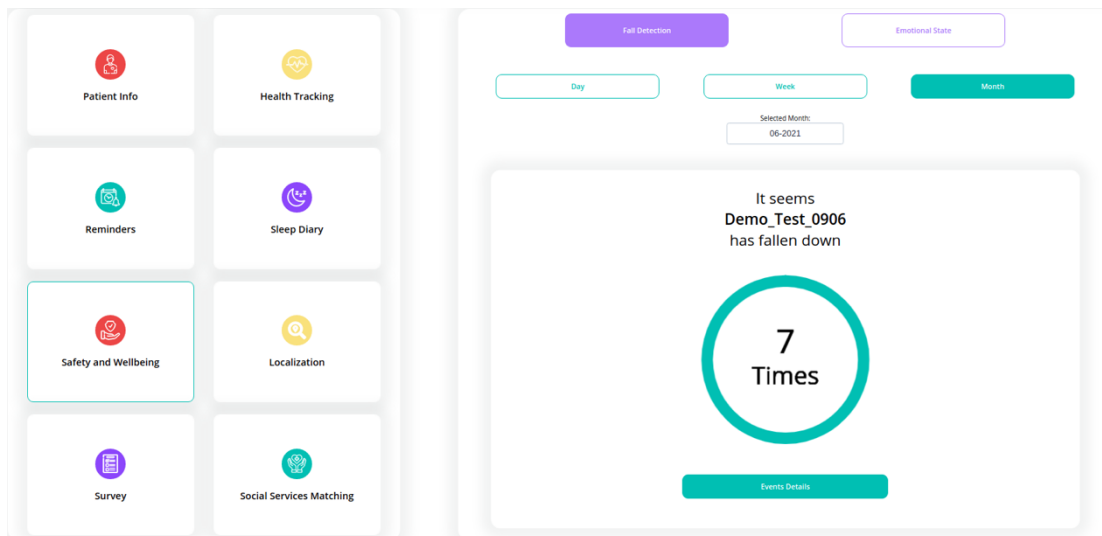

Figure 35 - Fall Detection component.

For fall detection, the main goal is to inform the user of the number of times the patient has fallen. In the emotional state component, a percentage is calculated to compare both options available (happy or sad) and to provide a better understanding of it.
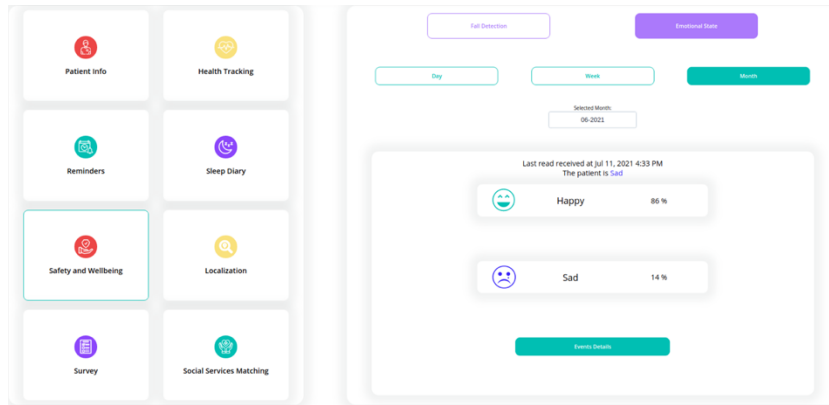Important to mention that the last read received is always displayed (only in the emotional state component).

Figure 36 - Emotional State component.

4.4.2.3.8 Patient's Details (Localization)

The following figure 37 is related to the localization component and its focus on the visualization of a chart. The chart informs the user of how much time the patient spent in a specific space, depending on the patient's environment. The 'Selected Location' option provides the patient's environments where the user can choose one. The search can be done by day, week, or month.
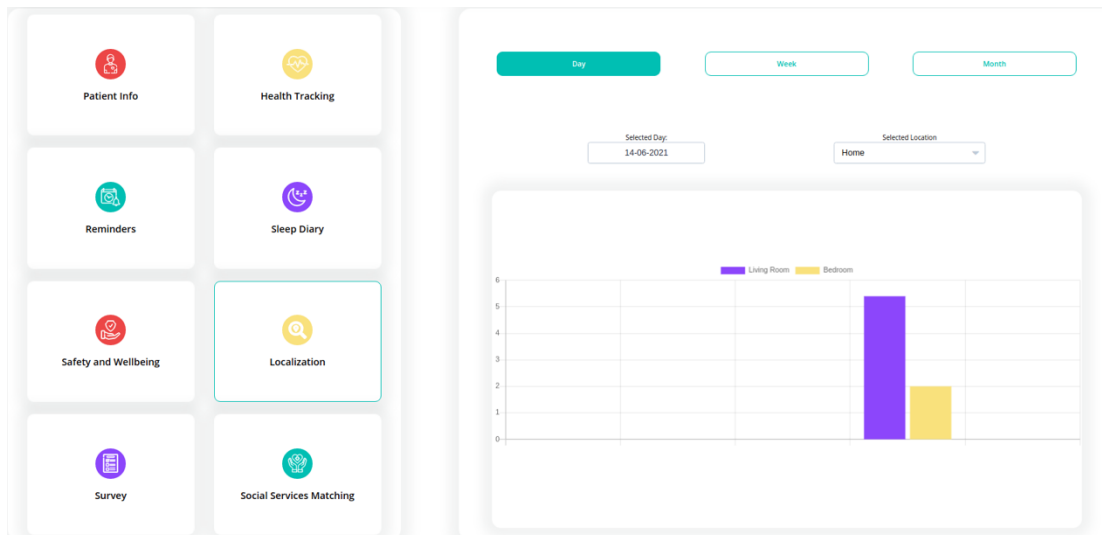

Figure 37 - Localization component.

4.5 Functionality and screens of the TeNDER App for caregivers and patients

The mobile app interfaces are mainly addressed to some categories of secondary end-users and people with cardiovascular diseases, Alzheimer's disease, Parkinson's disease, and those with comorbidities, called patients for explanatory simplicity.
In the following lines we are going to report:

- summary of the functionalities developed: standard functionalities and dedicated functionalities;
- description and related screen of each interface.

4.5.1 Functionalities and screens

After the development of the Mobile App for the TeNDER project, two main type interfaces were made for patient and caregiver use.

4.5.1.1 Standard functionalities

As above mentioned, the mobile app has two different interfaces for two kinds of users enabled to use the app, namely: first end-users (patients) and secondary end-users falling under various titles of formal and informal caregiver, family member, etc.
However, the mobile app foresees some functionalities that are common to all the final users, which we refer to and categorize as "standard functionality".
The following table (table 15) presents an overview with a brief description of all standard functionalities contained in the TeNDER APP.

Table 15 - Description of the Standard Functionalities of the Mobile APP.

Functionality	Description
Login	When a user wants to login, the process is always the same.
Logout	When a user wants to logout, the process is always the same.
Registration	Not implemented. The registration procedure involves filling the fields in several dedicated screens.
Settings	Functionality that enables users to access settings sections and edit information related to their "Profile", "Device Settings", layout preferences namely: Light Mode and Dark mode.
Show user's username and role	After login, any user has access to his username and role.

4.5.1.2 Primary end-users functionalities

In the following table (table 16), an overview of the mobile app components and their functionalities for primary end-users is presented.

Table 16 - Description of the mobile app Functionalities for patients.

Component	Functionality	Description
Home	Header	This sub-component is a dedicated bar at the top of the app to allow the user to visualize the notification centre as well as setting functionalities.
		Positioning the central part of the screen, the user can access specific functionalities for which it

	Middle section	has been decided, by priority order, to provide rapid and direct access from the first screen.
	Tab bar	Positioned at the bottom of the screen with four main icons: Home: to allow the user to return to the home section; Services: to access the services' general screen; Message: to access the social channels; Suggestion: recommendations.
Dashboard	Suite of services	Reference point for patients' end-users to have access to all the suite of services.
Services	Health Tracking	Displays last heartbeat rate received.
		Display last steps average received.
	Reminders	Display a calendar to check all the available reminders
		Visualize a list of reminders for a specific day and see if they were already read or not accepted.
	Sleep Diary	Display sleep score and further information related to last night's sleep of the user.
		Display duration, sleep depth, interruptions as additional information;
		Display a historical list of all scores.
	Safety and Wellbeing	Not implemented for the patient type of user.
	Localization	Not implemented.
	Survey	Not implemented.
	Social Services Matching	Not implemented.

In the next paragraphs, all the developed screens and a brief description of them are presented.

4.5.1.2.1 Home section

The home component of the TeNDER mobile App refers to the primary navigation screen for mobile devices, such as a smartphone or tablet. It contains several shortcuts to launch specific functionalities for patients. Using the main gestures supported by the App, users can navigate through it by clicking on a specific part of the screen, pulling down or swipe on all the screens. This main component foresees the following sub-components, screens, and functions:

Header: this sub-component is a dedicated bar at the top of the app allowing users to visualize and check notification (bell icon) and setting profile (gear), i.e.:

- *visualize notification (bell icon):* From the home by clicking the bell icon, the patient will be able to access the notification centre and visualize Reminder; Message; Suggestion; Device setting. However, even though the screens have been designed and implemented for use, it has been decided not to make this one usable for reminder services only (see Figure 38);
- *Settings functionalities (gear icon):* positioned at the right corner of the screen. By clicking on this icon, users can access settings sections and edit information related to their "Profile", "Device Settings", layout preferences namely: Light Mode and Dark mode, and setting side (see Figure 38).

Middle section: at the central part of the screen, the user can access the following two functions:
- Panic button (call for help): with this functionality, the patient can call a caregiver indicated by him/her. However, this functionality is not yet implemented;
- Next reminder: patients can visualize the next reminders, and in case the reminder has been visualized, it appears to be flagging;
- Direct useful services: access point to the core functionality of the app.

Tab-bar: subcomponents positioned at the bottom of the screen with four icons/items:
- Home: to allow the user to return to the home section.
- Services: to access to services' general screen.
- Message: to access to social channel.
- Suggestion: (recommendation).

However, not all screens were provided to the user during the first pilot because not all functionalities were ready yet, i.e.: Message and Suggestion. Therefore, in order not to confuse the user, those access points were deactivated by blanking out the relevant icons.
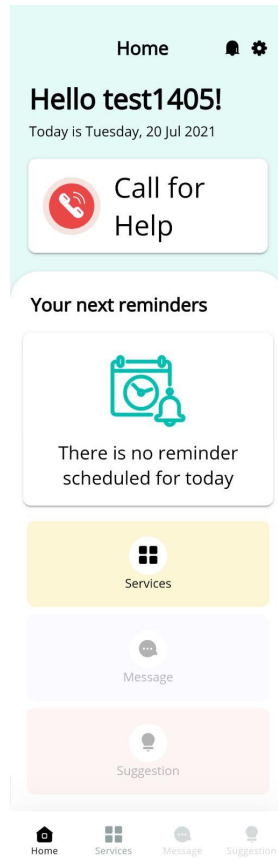
The following are all the screens mentioned above:

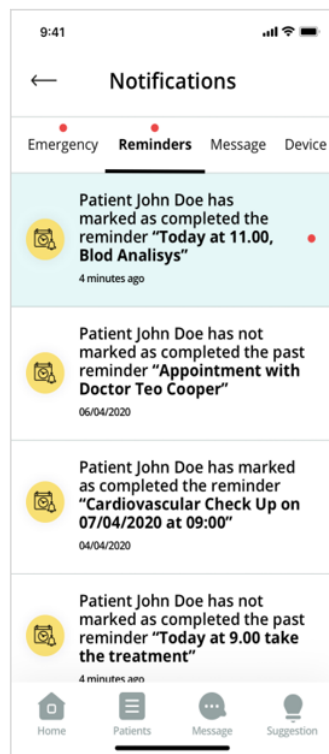*Figure 38 - Home section of the TeNDER App for primary end-users.*

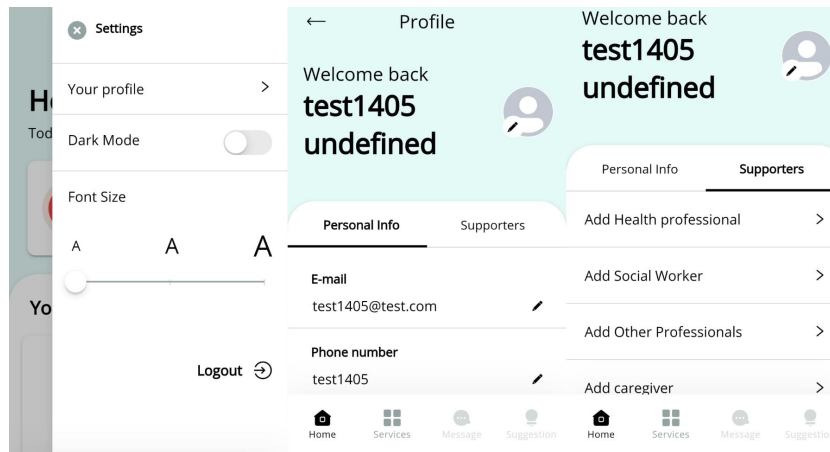*Figure 39 - Notification's centre of the TeNDER App for primary end-users.*

Figure 40 - Profile settings.

4.5.1.2.2 Dashboard and suite of Services

The dashboard is the main graphical user interface and component that provides at-a-glance views to users of all the functionalities and the main access points. From the Service dashboard, patients will be able to visualize all the data connected with the following services of the APP provided to each patient, namely:

- Health tracking;
- Reminder;
- Sleep diary;
- Safety and wellbeing;
- Social services matching;
- Survey.

Figure 41 - Dashboard of the TeNDER App for primary end-users.

Although the screens have been designed and implemented for use, it has been decided, in consultation with all partners, only to test and define the following patient-side services.

Besides that, it was decided to show only the services available and to avoid confusion. For this reason, the screen currently looks as shown in the figure below.
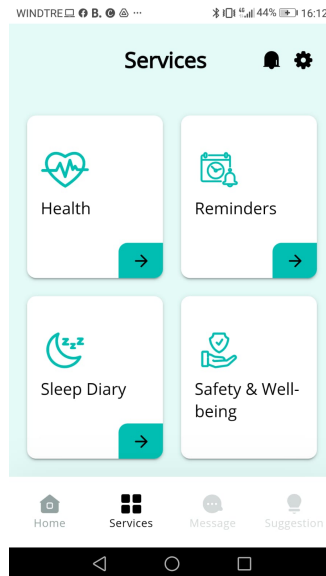
Figure 42 - Dashboard of the TeNDER App for primary end-users.

In the following paragraphs, the specific functionalities offered to the patient in terms of services are described and reported.

4.5.1.2.2.1 Health tracking Service

The screen below reported the health tracking service's information presented to each patient through dedicated interfaces.

This screen shows the following data to the user:
- last heartbeat rate received;
- last steps average received.

All the information on this screen is provided by inputs coming from wristband sensors worn by patients. Moreover, by clicking the synchronization button, users can view, on this specific screen, the current heart rate and the number of steps taken.
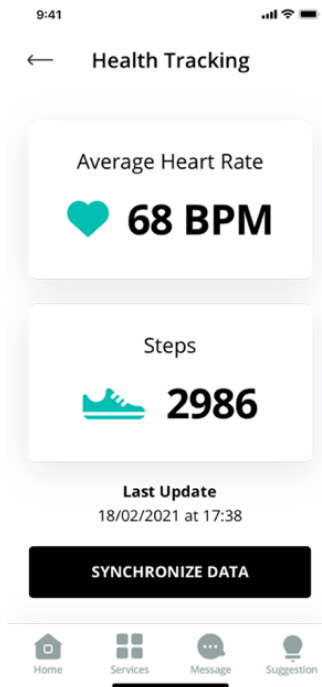
Figure 43 - Health Tracking service.

4.5.1.2.2.2 Reminder service

This service will enable users to visualize reminders that are provided via a notification (in the notification centre). Specifically, on this screen users can: display calendar, display list of reminders in chronological order, and display reminder details.
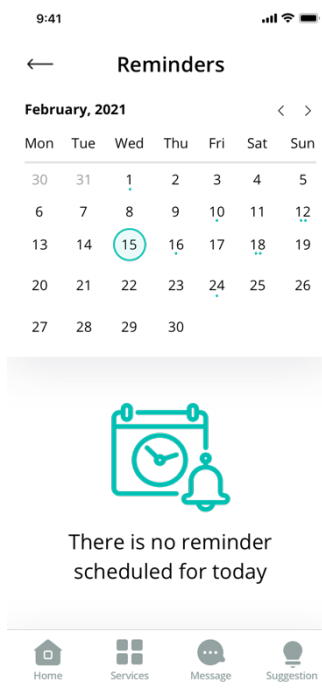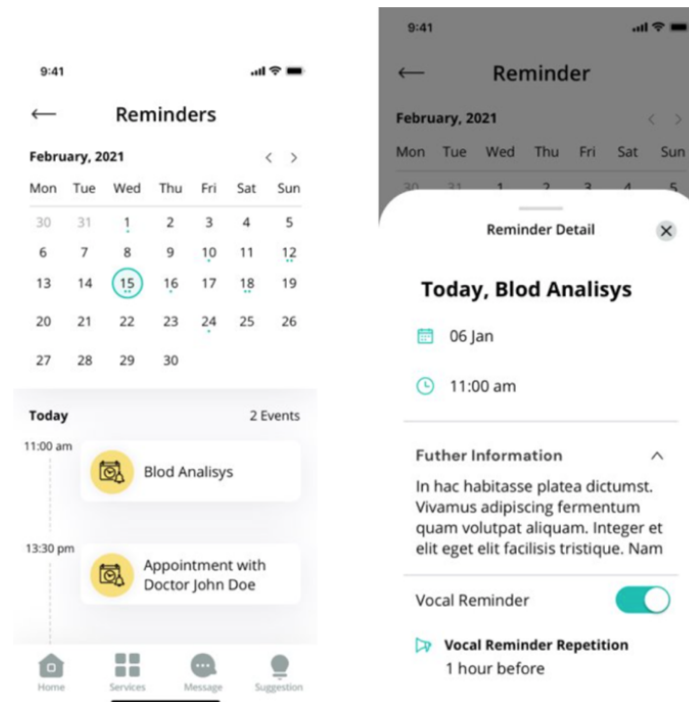

Figure 44 - Reminder's calendar service.

Figure 45 - Reminder service.

In the next developments, a vocal reminder option will also be integrated, so that the patient can decide with a switch whether to receive this message, which will be played back to him through the speaker.

4.5.1.2.2.3 Sleep diary

Through this screen, reported in the figure below, patients will visualize their sleep diary. Specifically, patient can visualize the following information:

- Sleep score: the percentage of sleep trend;
- Duration: total sleep time, Depth: sleep deepness;
- Sleep score detail: historical list showing all scores.
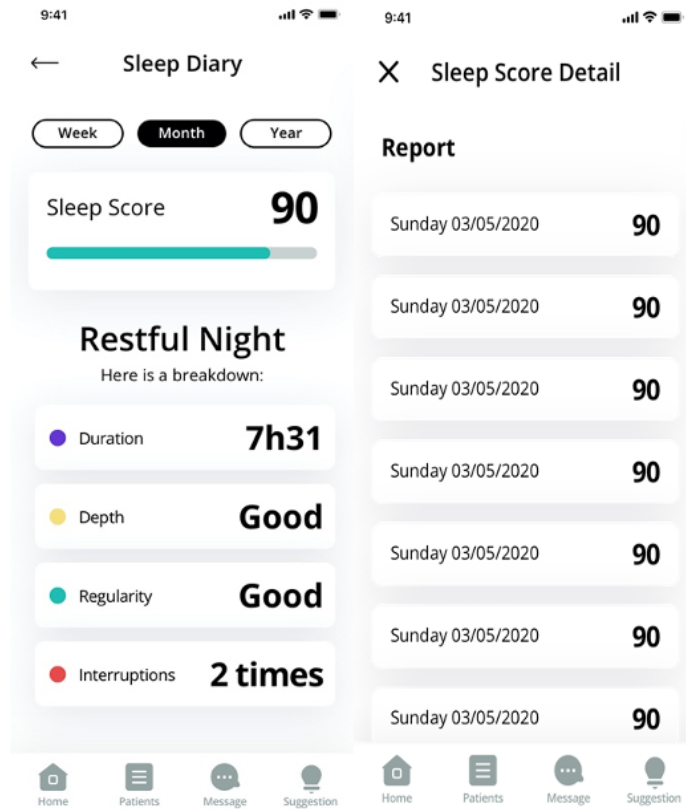
Figure 46 - Sleep score and details.

4.5.1.3 Secondary end-users functionalities

The following table presents an overview of the functionalities integrated addressed only to the secondary end-user interface.

Table 17 - Description of the mobile app Functionalities for secondary end-users.

Components	Functionality	Description
Home	Header	This sub-component is a dedicated bar at the top of the app to allow the user to visualize the notification centre as well as setting functionalities.
	Middle section	Positioning in the central part of the screen, the user can access the specific functionalities for which it has been decided, in accordance with the order of priority, to provide rapid and direct access from the first screen.
		Positioned at the bottom of the screen with four icons:

	Tab bar	Home: to allow the user to return to the home section; Services: to access the services' general screen; Message: to access the social channels; Suggestion: (recommendation).
Patients List	List all user's patients	List all user's patients where the caregiver will have the possibility to choose a patient and therefore visualize his details.
	Search for patient	Search for a specific patient through his name or username.
Dashboard	Patient details	Reference point for caregiver to have access to all the patients' details.
Patient details	Health Tracking	Display the last heartbeat rate of the patient chosen from the list.
		Display the last steps average of the patient chosen from the list.
	Reminders	Display a calendar, enabling caregivers to set up a reminder.
		Display a calendar, enabling caregivers to create new reminders.
		List reminders for a specific day and see if they were already read or not from patients;
		Display sleep score and further information related to last night sleep of the patient chosen from the patient list.
	Sleep Diary	Display duration, sleep depth, interruptions as additional information of the patient chosen from the patient list.
		Display a historical list of all scores of the patient chosen from the patient list.

		Display the patient's emotional state percentage through sad or happy data.
	Safety and Wellbeing	Display the patient's emotional state event's history.
		Display the number of falls and the possibility to list its history for a specific day, week, or month.
		Display fall event's history.
	Localization	Not implemented.
	Survey	Not implemented.
	Social Services Matching	Not implemented.

4.5.1.3.1 Home section

Same as for patient users, the home component is the main section and is a reference point for caregiver users for all the functionalities offered by the App. It contains several shortcuts to launch specific functionalities for patients. Using the main gestures supported by the App, users can navigate by clicking on a specific part of the screen, pulling down or swipe on all the screens.
This main component foresees the following sub-components, screens, and functions.
From this section, the patient can visualize:
Header: this component is a dedicated bar at the top of the app to allow the user to:

- *visualize notification (bell icon):* From the home section, by clicking on the bell icon, caregivers will be able to access the notification centre and visualize Reminder; Message; suggestion; Device setting. The user experience of this screen is the same as the one presented above for patients (see Figure 48);

- *Settings functionalities (gear icon):* positioned at the right corner of the screen. By clicking on this icon, users can access settings sections and edit information related to their "Profile", "Device Settings", layout preferences namely: Light Mode and Dark mode, setting side, Add Patient/Accept/Reject a request from a patient. Moreover, to add a patient, the user can view a list of patients and choose one among those already present (see Figure 48 below).

Middle section: At the central part of the screen, caregivers will be able to see important notifications.
Tab-bar: subcomponents positioned at the bottom of the screen with four icons/items:
- Home: to allow the user to return to the home section;
- Patients: to access the patient list;
- Message: to access social channel;
- Suggestion: (recommendation).

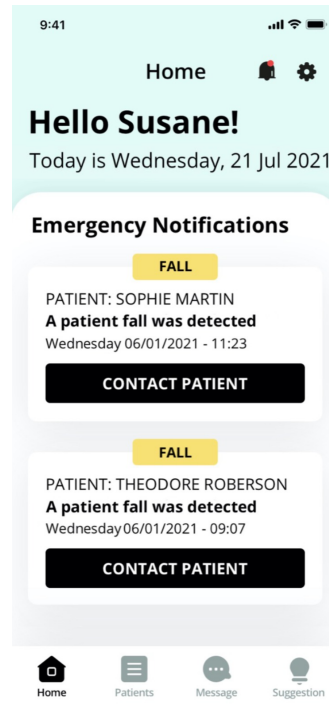The following are all the screens mentioned above:

Figure 47 - Home section of the TeNDER App for secondary end-users.
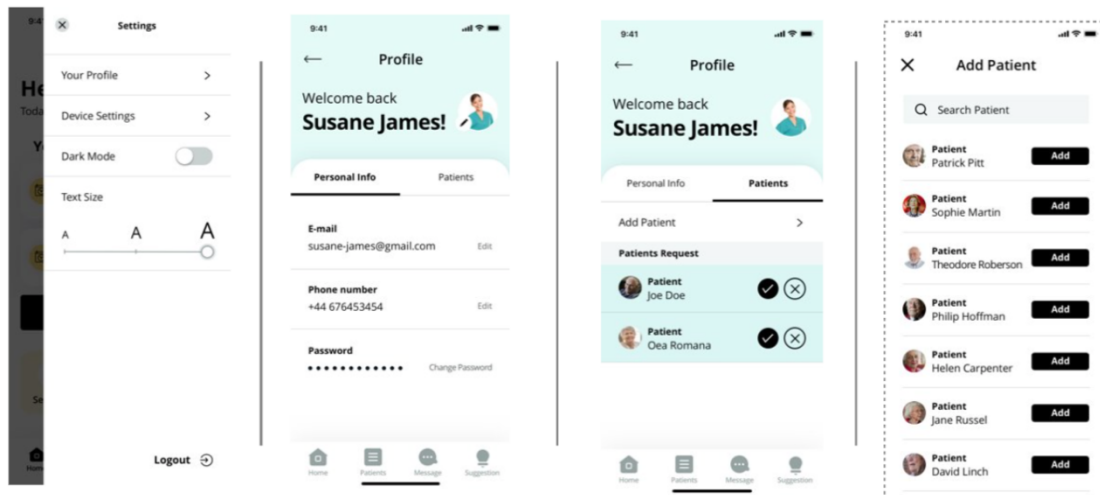

Figure 48 - Setting profile.

4.5.1.3.2 Dashboard and Patient list

From the dashboard component, caregivers can view the list of patients associated with him/her, and for each one, they can visualize the respective details. As for the patients, also for caregiver screens, it has been decided, in consultation with all partners, to test and define only the following patient-side services and to avoid confusion:

- Health tracking;
- Reminders;
- Sleep diary;
- Safety and wellbeing.

Through "Patient List" screen, all secondary end-users visualize the following information of the connected patient:

- List all user's patients to see patient details.
- Search for a specific patient through his name or username.

Both screens are shown in the figure below.
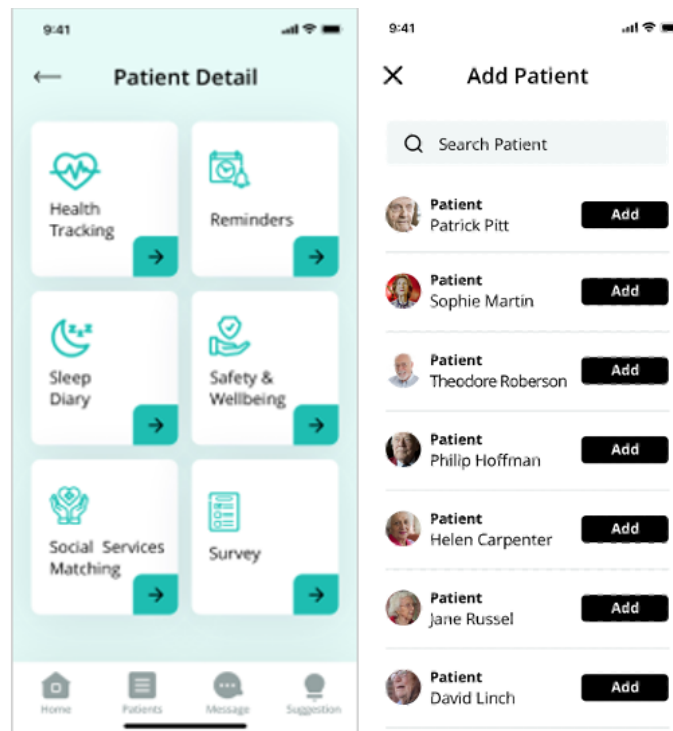
Figure 49 - Dashboard and Patient List.

4.5.1.3.3 Patient details

The following paragraphs describe and report the specific information and data detected through the TeNDER sensor ecosystem, provided in terms of "patient details" for caregivers instead of a suite of services as it is for the patients. As the difference between the patient and caregiver interface may not seem very evident, it is important to mention that the implemented structure uses a common congruent logic that will allow, in future developments, to dedicate screens with clearly delimited differences for each type of user.

4.5.1.3.3.1 Patient details (Health tracking)
The following screen show to the patient-user:
- the last heartbeat rate received;
- the heartbeat rate and steps average for a specific day, week, or month;
- the list of all the events for a specific day, week, or month.
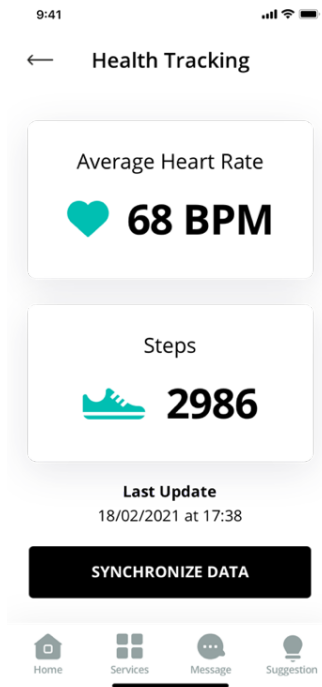
Figure 50 - Health Tracking from Patient List.

4.5.1.3.3.2 Patient details (Reminders)

This service enables secondary end-users to edit reminders addressed to patients.
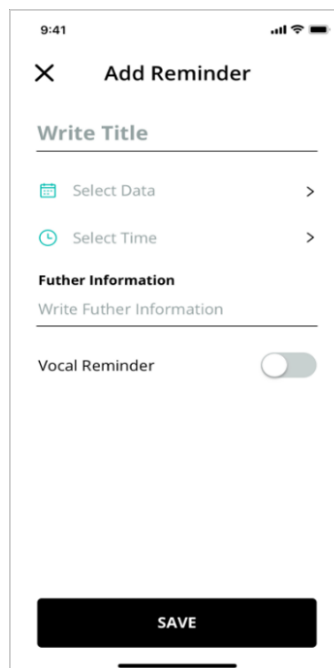
Figure 51 - Adding a new Reminder.
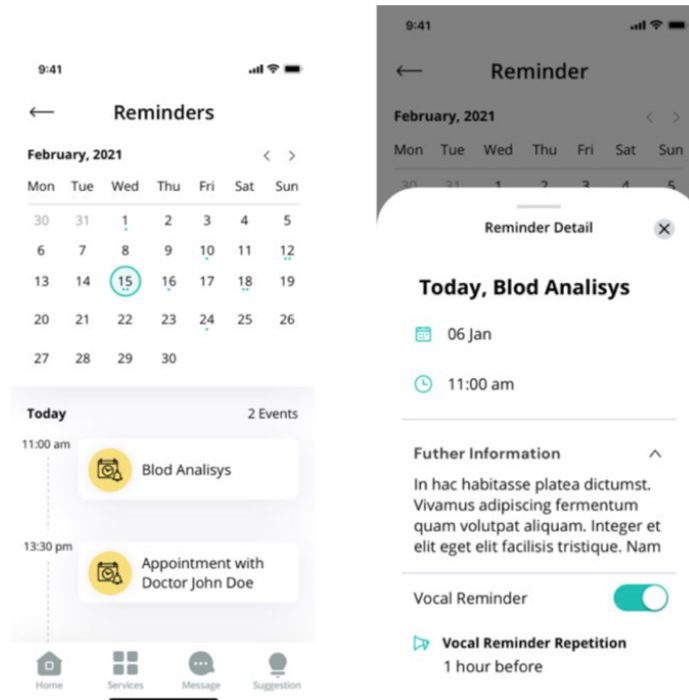
Figure 52 - Reminder Service.

4.5.1.3.3.3 Patient details (Sleep Diary)

Through this section, secondary end-users visualize the following information of connected patients: sleep score, duration, sleep depth and interruptions.
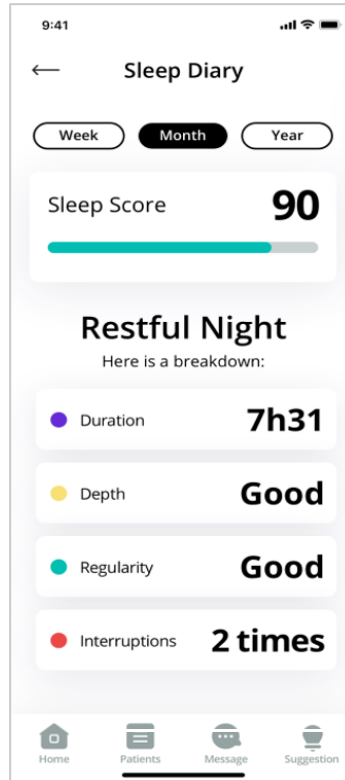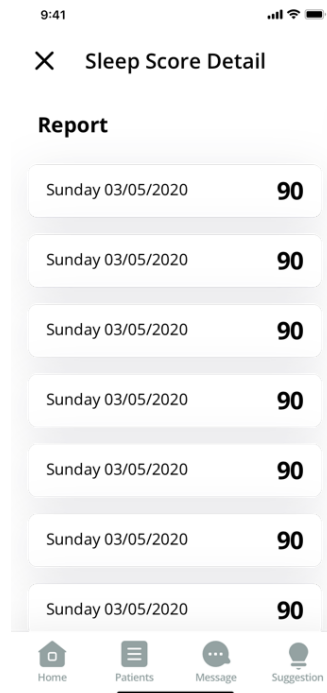

Figure 53 - Sleep Diary.

Figure 54 - Sleep score detail.

4.5.1.3.3.4 Patient details (Safety and Wellbeing)

In this section, secondary end-users visualize emotional state percentage through sad or happy data and the possibility to list its history (display the last emotion received and when).
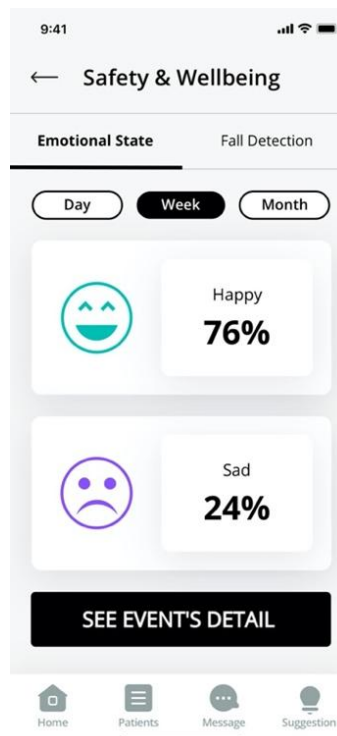
Figure 55 - Safety and Wellbeing patient details.
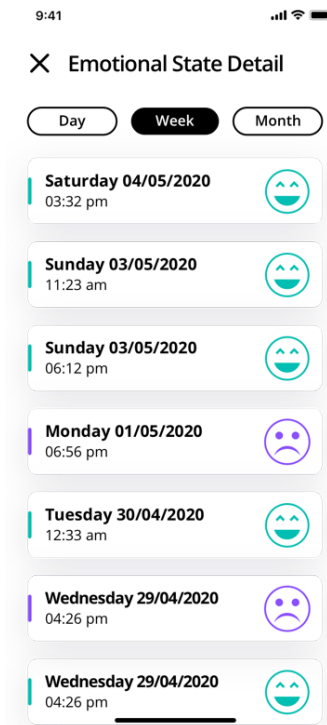
Figure 56 - Emotional state detail.

The following figures (Figure 57 and 58) show the number of falls and the possibility to list its history for a specific day, week, or month.
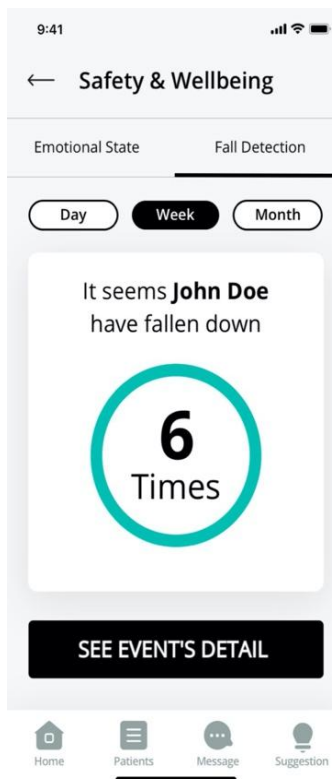
Figure 57 - Fall detection.
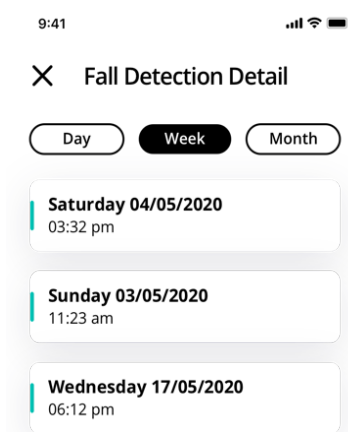
Figure 58 - Fall detection detail.

5. CONCLUSION AND NEXT STEPS

This deliverable presents both the user interfaces and the interaction with backend services, as they have been designed and developed for the first wave of piloting in the TeNDER project. Following a co-design approach with the user partners, the user requirements and scenarios were collected. Based on the information gathered, different interfaces for each user role were designed and developed. So, the patients and caregivers can interact with the platform using TeNDER's Hybrid App and health professionals can use a web-based one, specially designed to fulfil their needs. It's worth mentioning that both interfaces comply with different types of devices (i.e. smartphones, tablets, personal computers, etc).

Nevertheless, the co-design is still in progress, so the efforts to enhance the user experience and the performance of the functionalities continues. Specifically, the consortium will work to address the feedback that will arise after the second and third wave of Pilots. Moreover, all the discussions with end-user partners and technical partners will continue via product management meetings and technical meetings following a continuous integration framework.

In the next few months, new features and functionalities will be added, in strict correlation with the releases that will happen on the backend, in the low-level subsystem, and the high-level subsystem. Regarding the app, dedicated users will be activated on the most common marketplaces like google Play store and Apple store, allowing users to download the app for android and IOS.

The report regarding the final version of the user interfaces and the backend APIs will be presented in the deliverable D5.5, which is the final deliverable of the WP5.

6. REFERENCES

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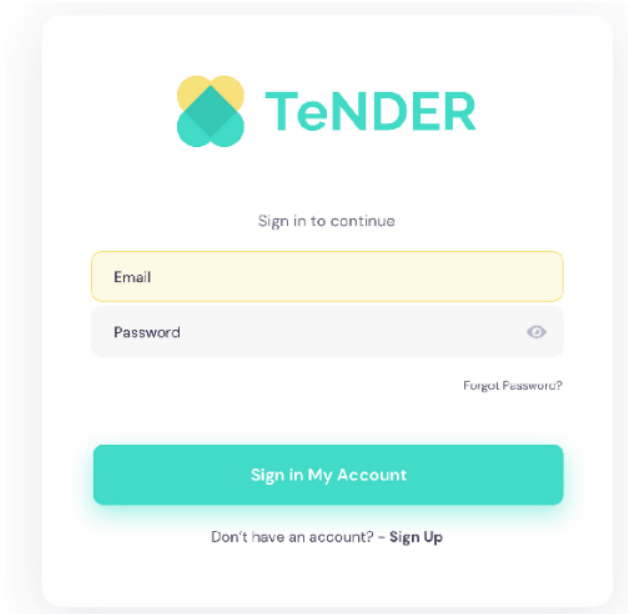
7. ANNEXES

A. Mock-ups

Figure 59 - Web App's Login Page.

This first figure (Figure 59) is related to the login page. All the users need to write in their credentials to be able to access their private area.
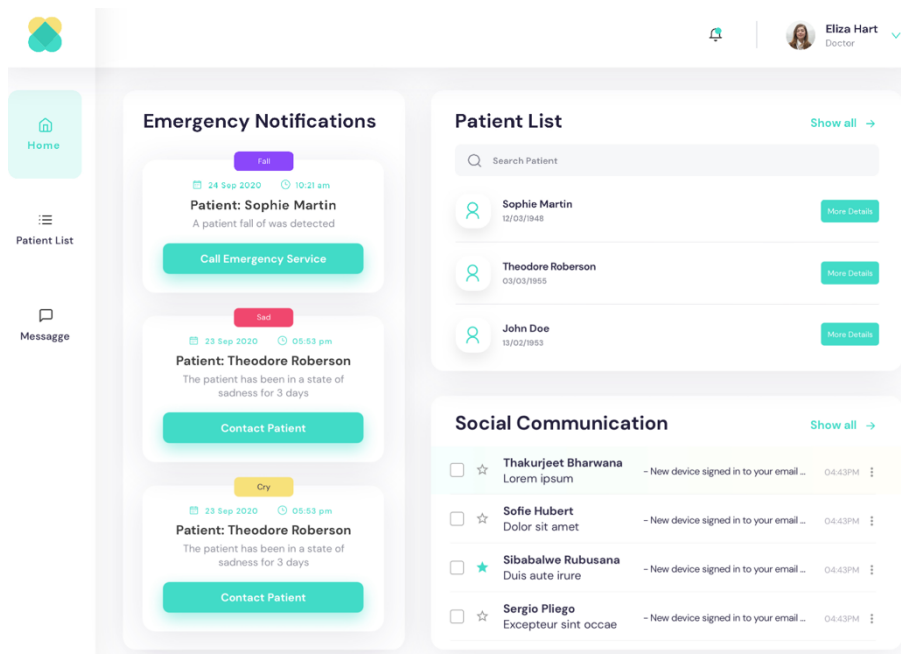

Figure 60 - Web App's Main Page.

The figure 60 exposes the main page to which the user is redirected after the successful login. It includes three main components where it is possible to visualize:
   – Emergency Notifications: All the events that indicates a patient's fall, sadness or leave house will be displayed with additional information to better define it;

– Patient List: The last three patients associated are listed where is possible to go to their details page or search for any health professional's patient;
– Social Communication: List of social communications. It's possible to delete them or assigned as favourites;

Besides these components, there is a lateral bar on every page which contains three options that redirects the user to specific pages.
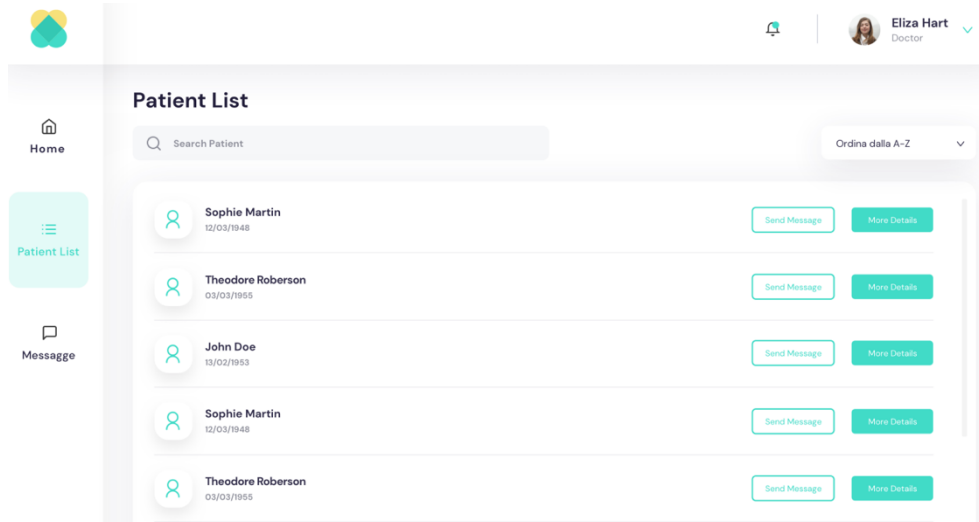
Figure 61 - Web App's Patient List.

The second component in the lateral bar redirects to the patient's list page. It shows all the patients associated with the logged health professional, allowing the search for a specific patient, ordering the list by name and, on each patient, sending a message or going to its details page.
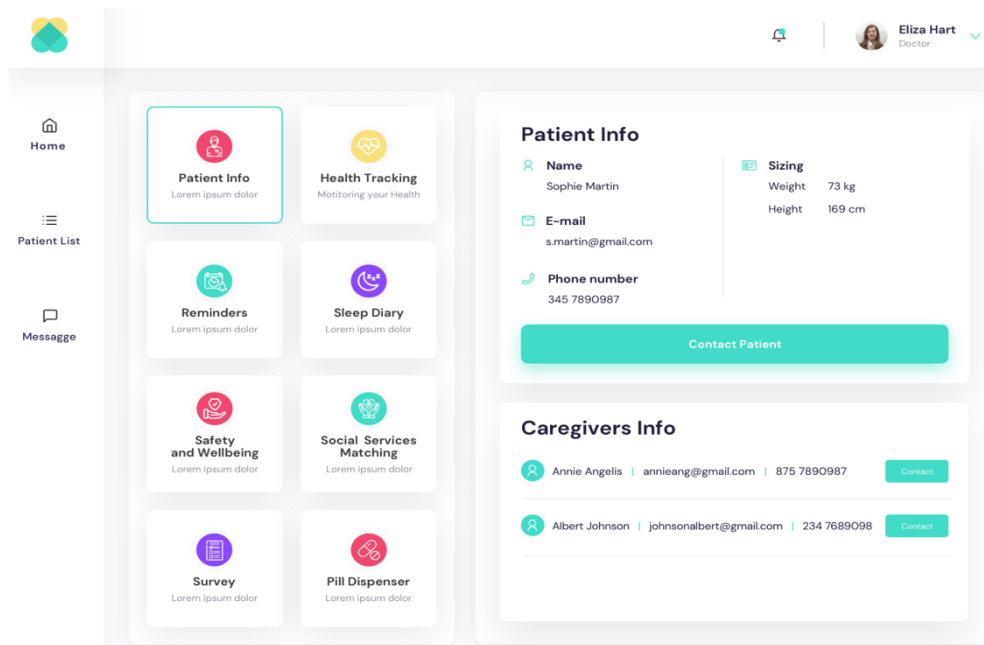
Figure 62 - Web App's Details Page.

On entering in the patient's details page, two main components are exhibited where, depending on the option chosen in the left component, the second component's data will

comply with it. In this mock-up, only eight functionalities are integrated, but depending on the type of data collected, several more could be added, which brings future changes to their display. The first one, it's related to patient information. Its data, if it exists, is displayed with the option to contact the patient. The remaining component lists the patient's caregivers' general data.
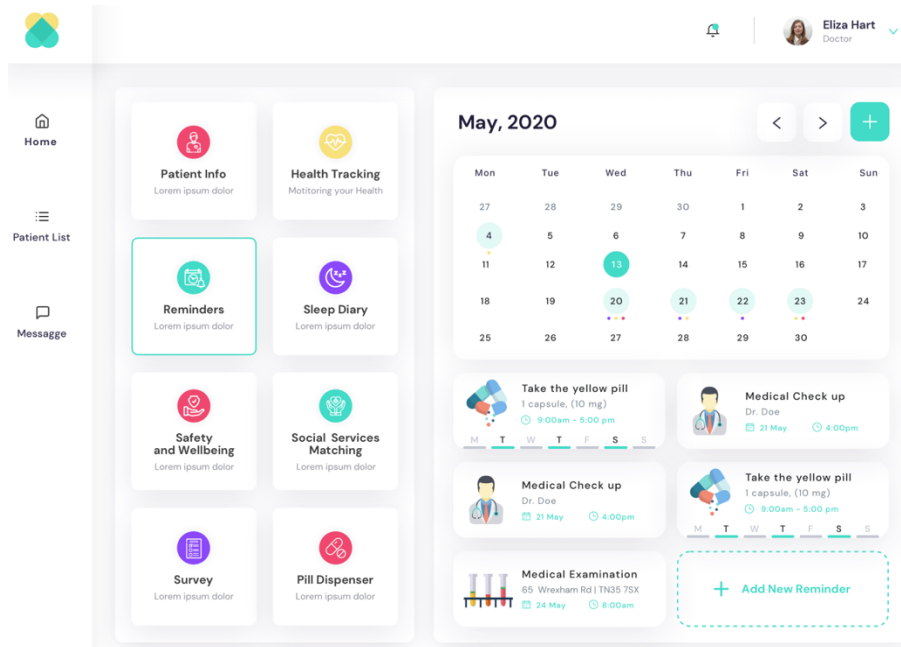

Figure 63 - App's Reminders List Component.

The reminders functionality exposes a calendar where the days, for which reminders are added, have marks, depending on the reminder's type. Below it, it's possible to visualize the reminders for a specific day and add new ones.
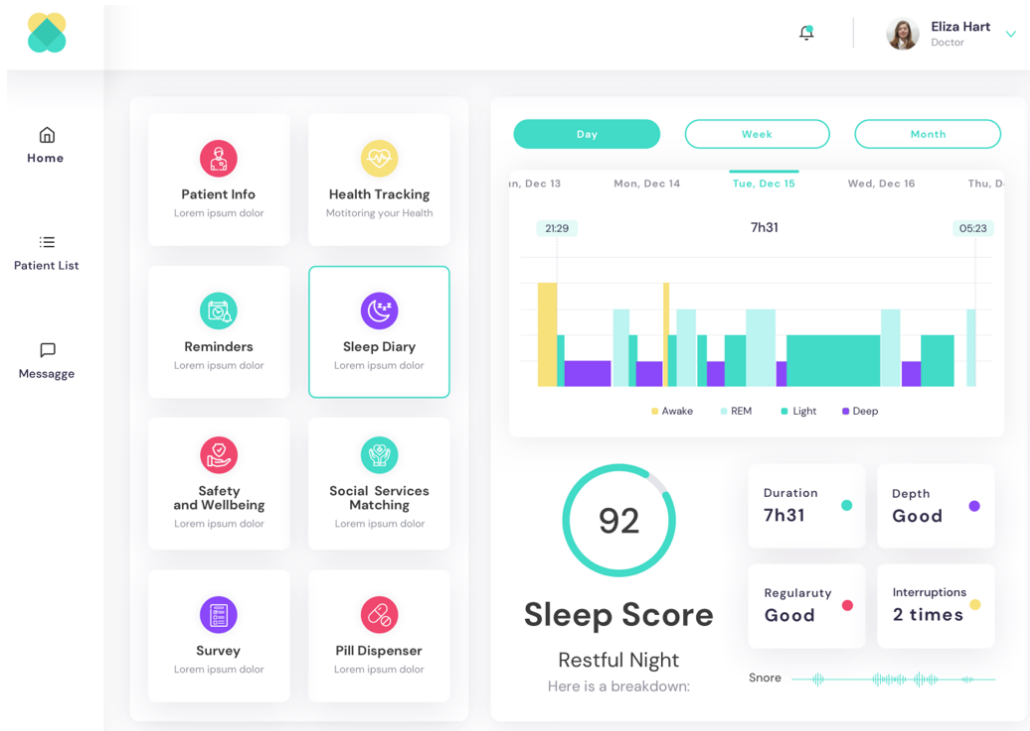
Figure 64 - App's Sleep Diary Component.

The last mock-up is related to the sleep diary functionality. It provides data of the patient's sleep quality. Several types of data visualization are displayed to improve its perception, organization and interaction. The data can be seen by day, week and month.

B. Style guide and Accessibility test

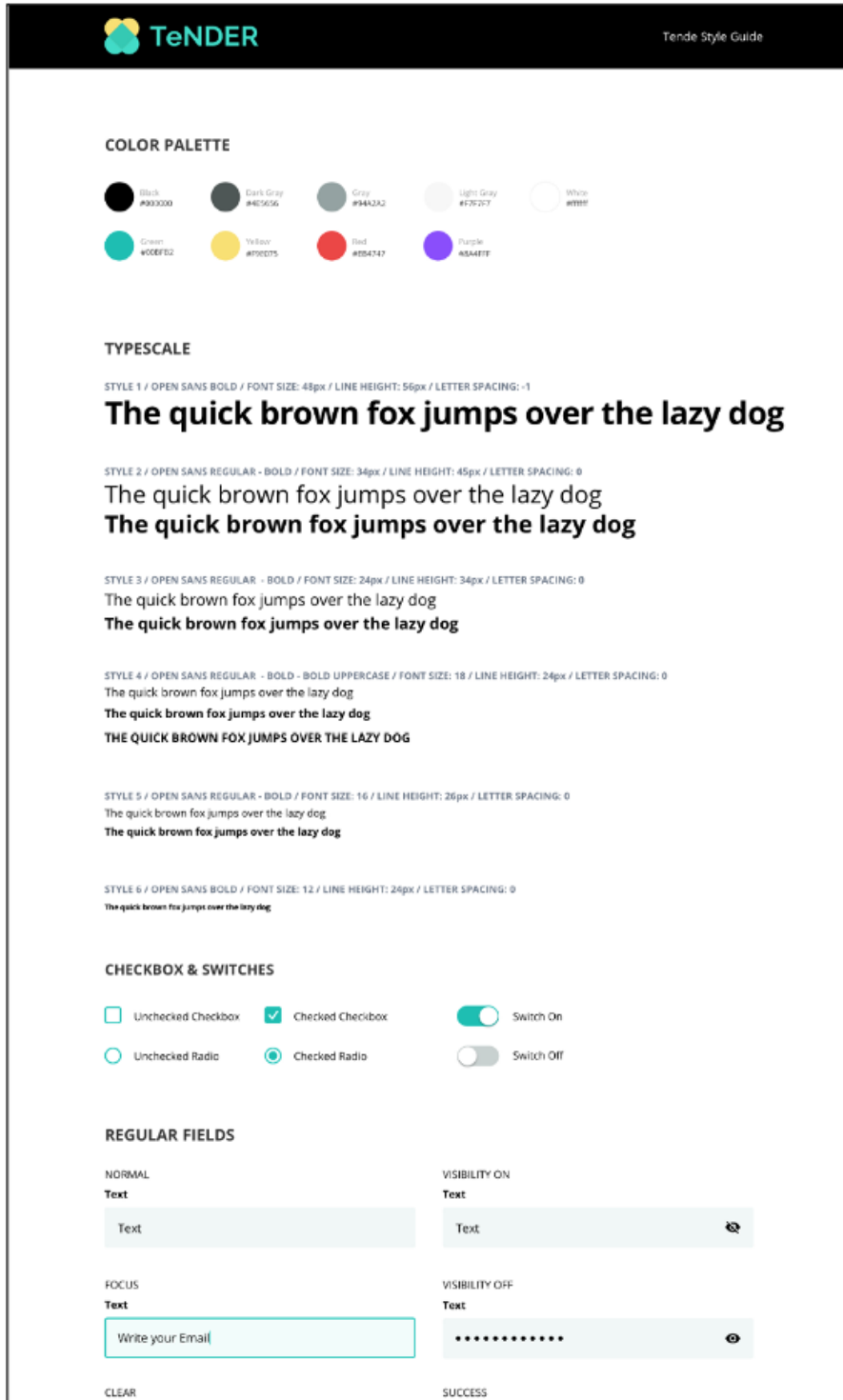Below we reported the style guide, which means the design document used to establish a set of standards and ensure accessibility standards of the TeNDER front-end.

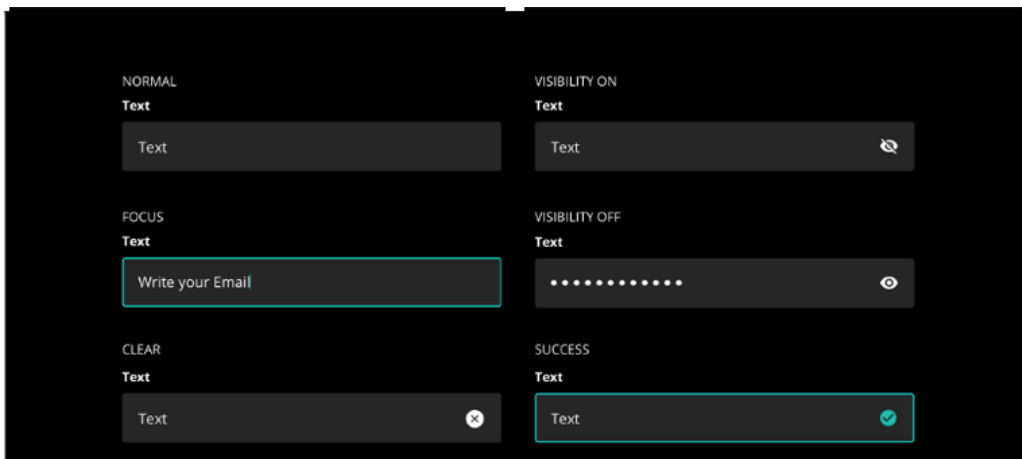*Figure 65 - Style guide (part 1).*
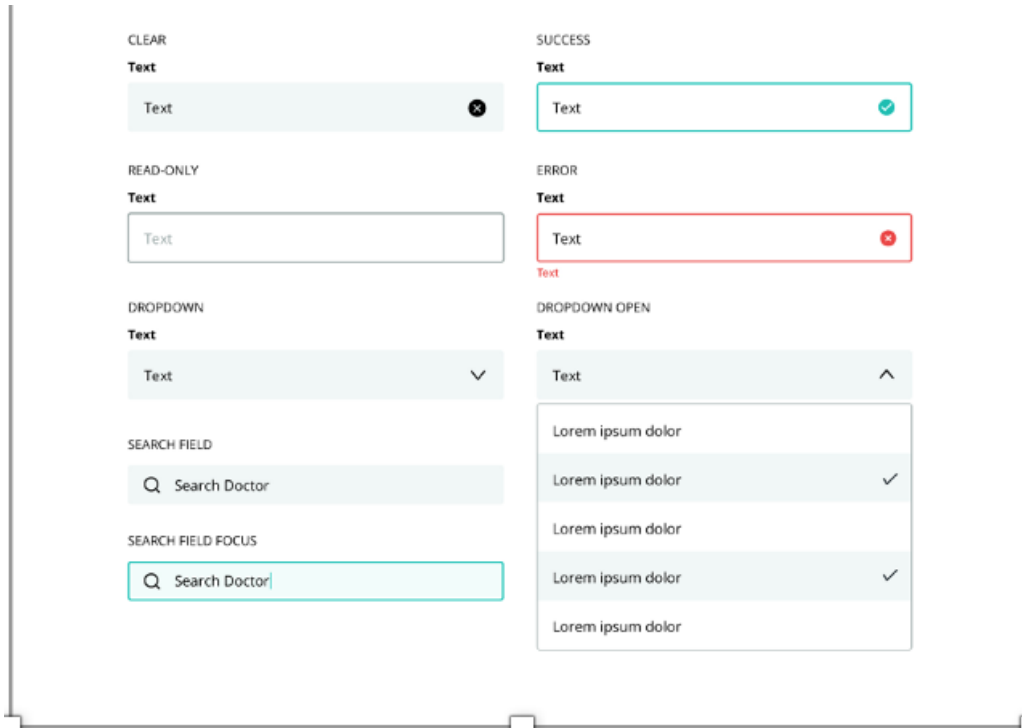
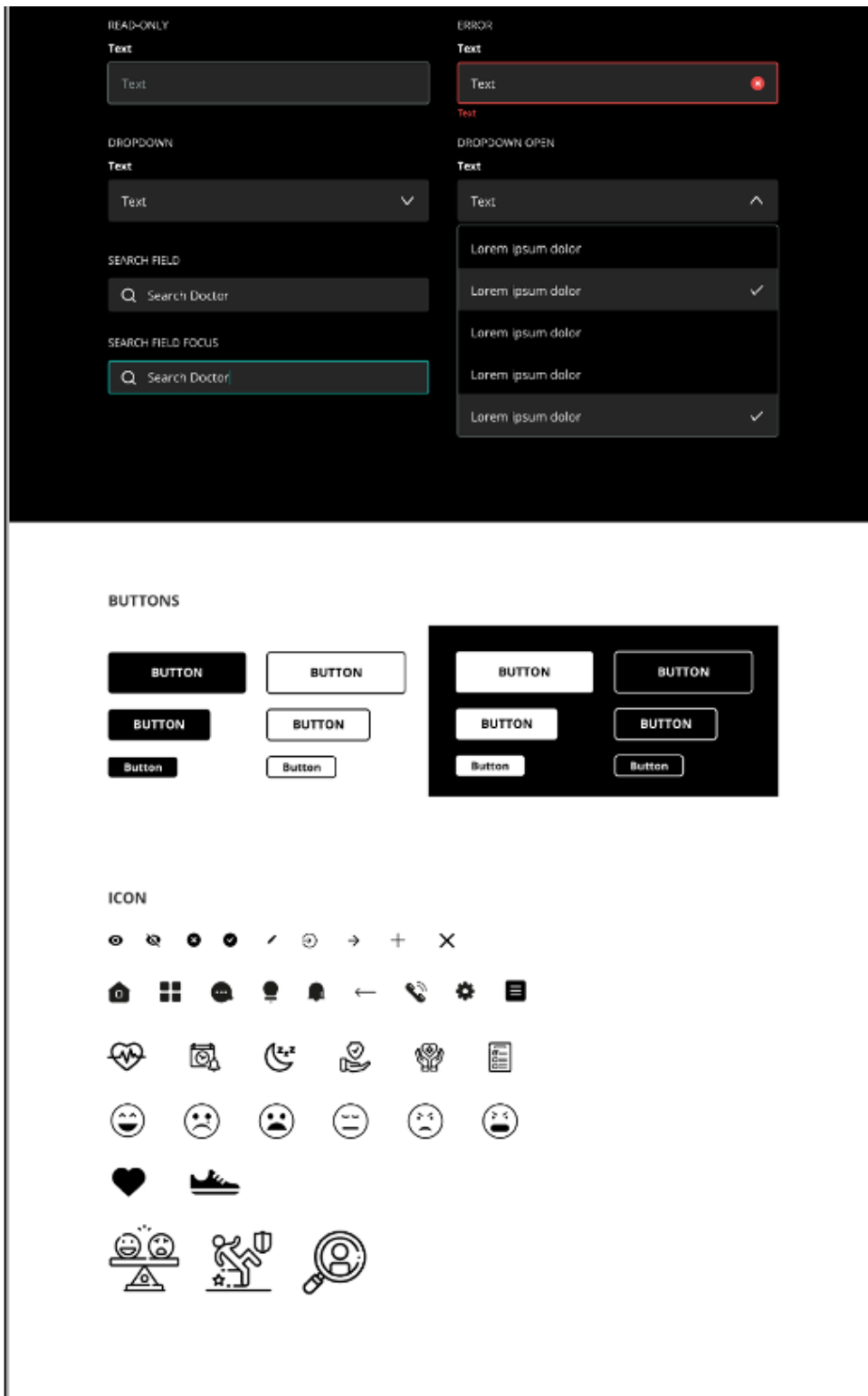*Figure 66 - Style guide (part 2).*

Figure 67 - Style guide (part 3).

Figure 68 - Style guide (part 4).

The following figures (Figure 69 and 70) report the result of an internal test on the accessibility of the mobile app.
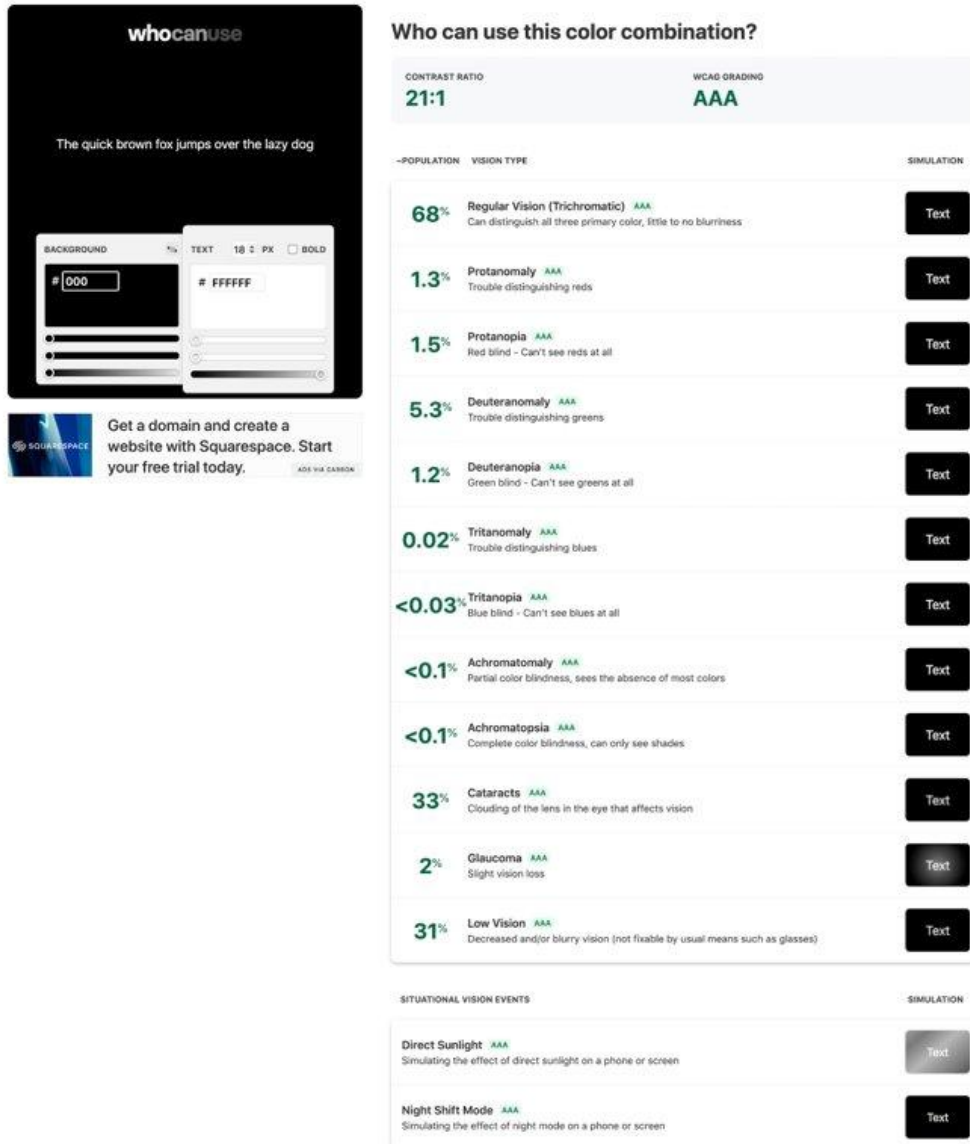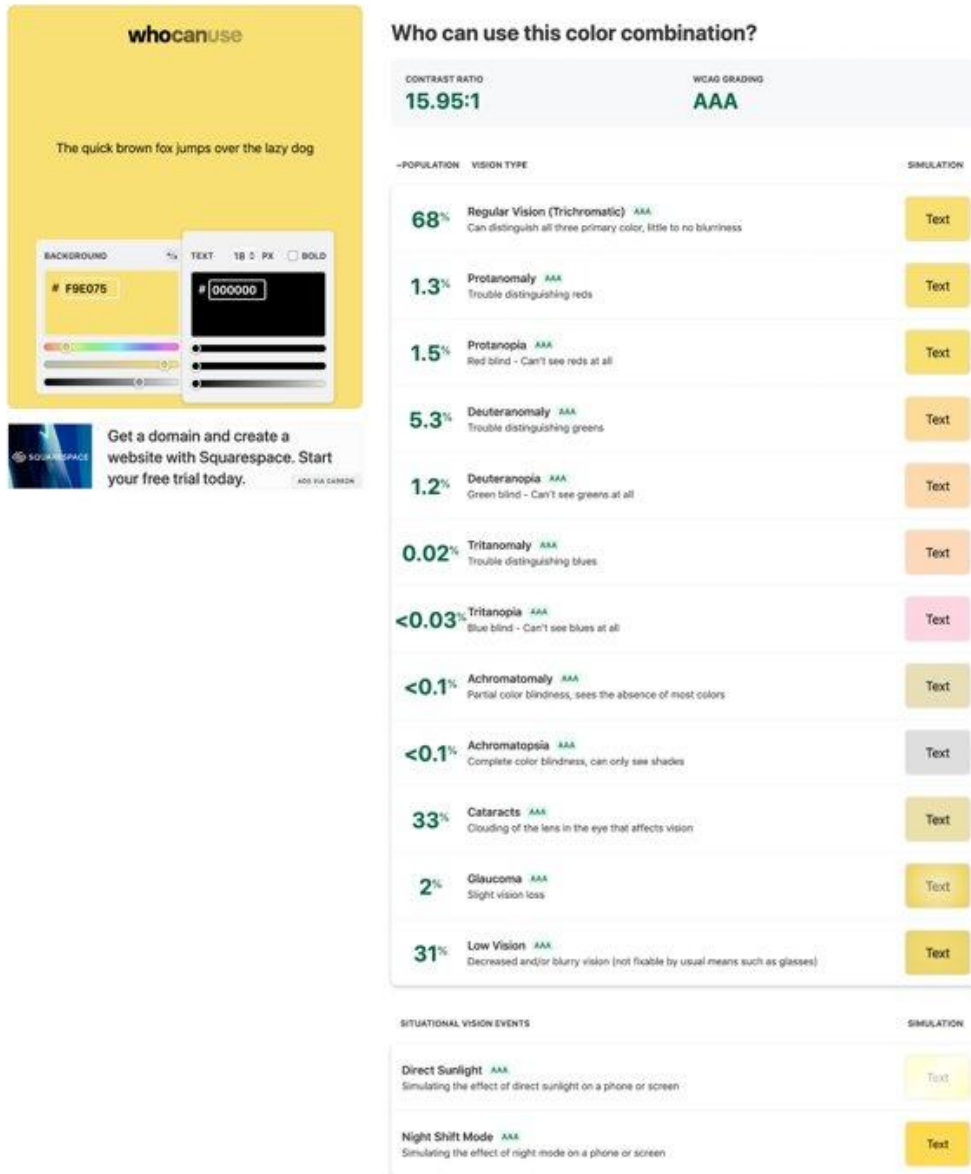
Figure 69 - Accessibility Internal Test Results (part 1).

Figure 70 - Accessibility Internal Test Results (part 2).