POLITECNICO
MILANO 1863

SCUOLA DI INGEGNERIA INDUSTRIALE
E DELL'INFORMAZIONE

Medical Informatics project

Modeling report

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Spring 2023

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Project at a glance

Bipolar disorder (BD) is a serious mental health condition that results in maniac and depressive periods. In maniac or hypomania stages, the patients mostly feel euphoric, fully energetic, speak rapidly, and may show risky behaviors as well as agitation. While in depressive periods, most of the time they are numb to good experiences such as sleeping, eating their favorite food, and laughing with their loved ones. They feel unloved, unworthy, and alone. [1]

One of the most serious but unfortunately common mood disorders is Depression. It has different types based on the symptoms that patient experiences in at least a 2-week period, but in all of them, depressed person suffers from loss of interest and pleasure, “empty” mood, pessimism feelings, changes in appetite, difficulty in sleeping and many other troublesome symptoms. [2]

People with mental health issues, not only experience lower quality of life in compare with others due to the psychological factors which leads to hopelessness and unsatisfaction in life, but also there are several studies shown that these conditions make patients more prone to cardiovascular diseases. According to [3] CVDs are the top cause of death in people experiencing serious mental health issues (SMI) which include disorders such as bipolar disorder, major depressive disorder, schizophrenia, and schizoaffective disorder.[4]

Regular monitoring of patients with mental health issues could be beneficial regarding two different points of views. In one hand, continuous monitoring of patients leads to a better follow up for mental health treatment which helps elevating outcome of therapy. Providing a more customized plan for a patient’s treatment, a monitoring platform with the help of detailed and regular analysis of parameters such as sleep quality, heart rate, blood pressure, etc. could be a useful key for a better diagnosis and care.

In other hand, with the continuous monitoring of patients, healthcare providers could identify the early signs of CVDs much faster, hence implementing interventions rapidly to prevent or alleviate disease development. It worth mentioning that some parameter should be taken only in-hospital while others could be taken in-home as well as in-hospital.

The aim of this project is to provide a suitable home monitoring system for patients already diagnosed with bipolarity and/or depression health disorder. The platform will provide the possibility for patients the ability of communicating with their practitioners and technical administrator, uploading personal/health data trackable by doctors, managing their appointments with their physicians as well as many other options leading to a better treatment experience. It is hoped that this project would help all people involved in this journey to access a better tool for managing the condition and make their life much easier.

A. Context analysis

A.1 System modeling

Models are advantageous tools providing better understanding about the real world and they help us to predict, optimize and communicate better ideas in life.

The modeling of system in this project has comprised of three main parts including Use case, activity, and class diagrams. The first two are behavioral diagrams which portray a dynamic view of our system while the last one is considered a structural diagram that illustrates a static representation of system.

In a nutshell, use case diagrams only summarize the relationships between systems, actors and use cases which are functional representations for requirements in a system. To provide an understating about the flow of control in different activities, activity diagrams are used in this project in order to show not only the sequences of activities, but also concurrent ones taken in place. Class diagrams are used to model the objects in our system, to find out their relationships, to represent their attributes as well as the methods which are the services that classes provide.

It's worth to mention that textural description is one of the key tools used in this project that facilitates extracting useful information in order to develop the diagrams more detailed and comprehensible. It's an all-inclusive tool that specifies use cases, actors, pre and post conditions, basic scenarios, and alternative ones.

All in all, utilization of diagrams to quickly convey information in addition to textural description as a tool for providing more clarifications and details in the context, are the key points in modeling of this project.

In below, a brief introduction about bipolarity and depression will be discussed for context analysis of project.

A.2 Bipolarity

Bipolar disorders are considered as chronic mental illnesses with a wide range of complex conditions categorized in:

1) Bipolar 1: at least one maniac episode
2) Bipolar 2: a hypomanic episode and a major depressive episode, no maniac episode
3) Cyclothymic: cyclic hypomanic and depressive symptoms in a milder way in comparison with aforementioned episodes in bipolarity type 1 and 2 involving many mood swings
4) Other specified and unspecified bipolar/related disorder

Various states of mood that deviate from the norm, including feelings of extreme sadness, mental sluggishness, reduced drive, and impaired cognitive function, as well as feelings of great excitement, increased energy, and heightened cognitive and physical activity, have been

documented since ancient times. [5] However, the first time that they are all considered as symptoms of a particular disorder is on 1845 [6] which then in 19th century a full description has been provided by a German psychiatrist named Emil Kraepelin. [7]

Bipolar disorder is commonly identified in individuals during their late teenage years or early adulthood, but there are cases where bipolar symptoms can manifest in children. Despite the potential fluctuation of symptoms, lifelong treatment is typically necessary for managing bipolar disorder. [8]

This condition has great detrimental effect on patients' lives in terms of psychosocial functioning, illness related disability, economic and health costs.[9] Unfortunately, there is a high gap between the mortality in normal population vs people diagnosed with bipolarity disorder due to the CVDs and suicide in these patients. [10]

There are several mechanisms that explain the higher risk of cardiovascular diseases in patients with bipolar disorder:

1) Chronic inflammation:

   Several studies has shown that levels of proinflammatory cytokines have been increased in patients with bipolar disorder. [11] Bipolarity diagnose at younger ages in comparison to cardiovascular diseases. This suggests that inflammation associated with bipolarity, may lead to immune dysfunction which can cause atherosclerosis and cardiovascular diseases. [12]

2) Oxidative stress:

   There are some evidences suggesting that bipolarity can lead to oxidative stress which then could increase the risk for atherosclerosis, stroke and possible heart failure. Oxidative stress can cause endothelial dysfunction by damaging endothelial cells. These cells can produce nitric oxide, which prevents atherosclerosis. [13][14]

3) Certain medications such as antipsychotics and mood stabilizers

   Some medications used to treat bipolar disorder may cause insulin resistance,Dyslipidemia, and weight gain which can lead to higher probability of cardiovascular diseases.[15]

4) Lifestyle factors such as smoking, poor diet, sedentary behavior, and stress

   Patients with bipolarity mostly smoke more than other people, leading to a higher risk of CVD occurrence. A sedentary lifestyle due to lack of energy, motivation and fatigue can cause gaining weight, higher blood pressure and more risk of developing diabetes. Chronic stress is one of the conditions that bipolar patients suffer from and it could lead to high blood pressure, inflammation and formation of blood clots that may induce CVDs. [16][17]

The latest treatments for bipolar disorder are outlined in the guidelines, which recommend the use of mood stabilizers such as lithium, anticonvulsants like valproate and carbamazepine, and second-generation antipsychotics including quetiapine. Furthermore, psychosocial interventions like cognitive-behavioral therapy and interpersonal and social rhythm therapy are suggested as complementary to pharmacotherapy. [18]

A.3 Depression

Depression is a recurring mental disorder considered as global challenge, affecting 4.4% of the global population. Adolescents, typically between the ages of 14 and 25, are commonly affected, with a 4-5% prevalence rate in this age group. [19]

According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) [20], depression can be categorized into several types based on severity, duration and symptoms. These categories are:

1) Major depressive disorder (MDD): most common type. Loss of interest in activities, difficulty in concentration and etc.
2) Persistent depressive disorder (PDD): chronic form of depression, persistent low mood, and lack of energy.
3) Postpartum depression: common for women after giving birth. Symptoms are anxiety, sadness, and exhaustion.
4) Seasonal affective disorder (SAD): it occurs during winter months with less natural sunlight. Symptoms are low mood, fatigue, changes in appetite and sleep patterns.

Major depressive disorder can have so many negative impacts on patients' quality of life; In all the aspects of their life such as education, relationships, and employment. The financial burden of depression is considerable, which may worsen the motivation of these patients to follow their treatments. Due to the lack of motivation, not only patients mostly don't do physical activities but also changes in their appetite, may cause obesity, cardiac disease, and premature death, including suicide. [21]

According to the article "Depression and cardiovascular disease: mechanisms of interaction" [22], there are several mechanisms that may explain why depression increases the risk of cardiovascular disease (CVD). One mechanism is through the effects of depression on the autonomic nervous system and hypothalamic-pituitary-adrenal axis, which can lead to dysregulation of the cardiovascular system and contribute to the development of CVD[23]. Depression is associated also with increased sympathetic nervous system activity and decreased parasympathetic nervous system activity, which can cause increased heart rate, blood pressure, and inflammation.

Another mechanism is through the effects of depression on health behaviors, such as physical inactivity, poor diet, and smoking [24].These behaviors are major risk factors for CVD, and individuals with depression may be more likely to engage in these behaviors, thereby increasing their risk of CVD.

Furthermore, depression is associated with chronic inflammation, which can contribute to the development of atherosclerosis, a major risk factor for CVD [25]. Depression impairs the immune system's ability to respond to infections and other stressors, which can further contribute to inflammation and the development of CVD.

Finally, depressed patients have troubles with medication adherence and engagement in healthcare, which can lead to inadequate management of CVD risk factors and poorer health outcomes[24].

The most recent lines of treatment for depression include various classes of antidepressants, such as selective serotonin reuptake inhibitors (SSRIs) and serotonin-norepinephrine reuptake inhibitors (SNRIs), as well as psychotherapy approaches, such as cognitive-behavioral therapy (CBT) and interpersonal therapy (IPT). In addition, non-pharmacological interventions, such as exercise and mindfulness-based therapies, have also shown promise in the management of depression.[26]

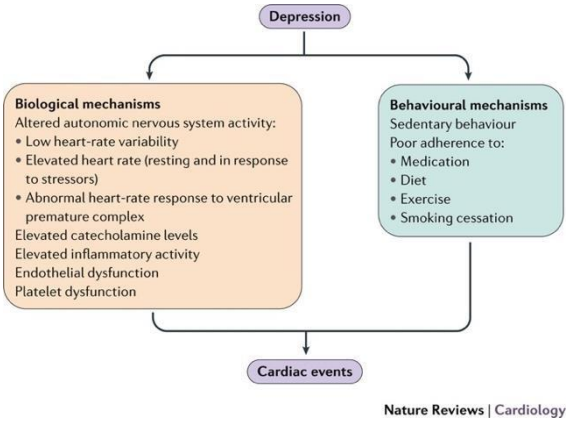

Figure 1 Potential mechanisms linking depression and coronary heart disease, DOI:10.1038/nrcardio.2016.181

1. Textural Descriptions

In this modeling we consider three types of actors which role the main acts of this procedure. However, it is obvious that in the real world, we would have another types of actors but adding them to this project will increase complexity of the project. The three main actors are Patient, Specialized practitioner, and technical administrator. In continuation, you will see the textual descriptions for all the users that explained necessary acts of actors in detail.

1.1 *User Login Textual Description

Tittle	**Login**
Description	The user login procedure to access the system.
Actors	User (Patient, Specialized practitioner), Software, Technical administrator
Pre-Condition	User has already been registered in the system
Post-Condition	User has Logged in to their profile.
Basic Scenario (BS)	1. User opens the software. 2. Software displays the login page. 3. User enters their “Username” and “Password” in the related fields. 4. User clicks on “Login” button. 5. Software displays the user’s area. 6. Use case finishes.
Alternative Scenario(s)	3.a: User forgot their password. 3.a. 1: User clicks on “Password recovery”. 3.a.2: Software displays the recovery page. 3.a.3: User enters their recovery e-mail. 3.a.4: User clicks on “send a recovery request” button. 3.a.5: Software Sends the request to the technical administrator. 3.a.6: Use case finishes. 5.a: User enters wrong username or password. 5.a. 1: Software displays the message” the Username or password is wrong”. 5.a.2: Return to step 2 at BS.

1.2 Patient's Textual Description

1.2.A Manage My Profile

Tittle	**Manage My Profile**
Description	Patient is able to observe/modify their profile information.
Actors	Patient, Software
Pre-Condition	User has already logged in to "Patient Area"
Post-Condition	User has observed their profile.
Basic Scenario (BS)	1. Patient clicks on "My Profile" button. 2. Patient observes their personal data: • Name • Surname • Gender • Marital Status • Codice Fiscale • Date of Birth • Place of Birth • Nationality • Address • Email • Phone Number • Profile Photo • Height • Blood type 3. Use case finishes.
Alternative Scenario(s)	2.a: Patient intends to modify their personal data. 2.a. 1: Patient clicks on "Edit" button 2.a.2: Patient enters new value for fields which must be edited. 2.a.3: Patient clicks on the "save" button. 2.a.4: Software pops up the confirmation message "Are you sure?" 2.a.5: Software updates the new value after patient's confirmation. 2.a.6: Software shows the message" Changes have saved successfully"

The “Manage My Profile” use case allows patients to view and modify their personal information in the “Patient Area” of the software system. The pre-condition for this use case is that the user must already be logged into their “Patient Area”. The basic scenario involves the patient clicking on the "My Profile" button, which takes them to a page where they can view their personal data. This includes details such as their name, surname, gender, marital status, codice fiscale, date of birth, place of birth, nationality, address, email, phone number, profile photo, height, and blood type. Once the patient has finished observing their profile, the use case ends.

There is also an alternative scenario where the patient can modify their personal data. In this scenario, the patient clicks on the "Edit" button, which allows them to make changes to their personal data fields. They can enter new values for fields that need to be edited and then click on the "save" button. After the patient clicks the "save" button, the software pops up a confirmation message asking if they are sure they want to make the changes. If the patient confirms, the software updates their profile with the new values and displays a message saying, "Changes have saved successfully." Once this process is complete, the use case finishes.

The “Manage My Profile” use case is an essential feature of the software system that allows patients to conveniently access and modify their personal information. It ensures that patient data remains accurate and up to date, which is important for providing high quality healthcare services. While the basic scenario simply allows patients to observe their profile, the alternative scenario provides additional functionality by allowing them to modify their personal data fields.

1.2.B Update health data

Tittle	**Update health data**
Description	Patient adds at-home health parameters to the system and fills in the questionnaires.
Actors	Patient, Software
Pre-Condition	User has already logged in to “Patient Area”
Post-Condition	User has updated their health data.
Basic Scenario (BS)	1. Patient clicks on “My Health Data” button. 2. Patient selects “Update New Health Data” button. 3. Software displays the health parameters: A) File type (.csv) to be uploaded: • Heart rate • Blood pressure • Physical activity • Sleep quality B) Manual data to be inserted: • Weight • Glycemia C) Questionnaires to be filled up: • Therapy Adherence • Patient Health Questionnaire 4. Patient updates the data. 5. Patient clicks on the “save” button. 6. Software updates the health parameters. 7. Software shows the message” Changes have done successfully." 8. Software calculates and stores the score related to patient’s questionnaire. 9. Use case finishes.
Alternative Scenario(s)	2.a: Patient wants to check their health data. 2.a. 1: Patient clicks on “Previous health records.” 2.a.2: Patient chooses the desired date. 2.a.3: Software shows the chosen records. 2.a.4: Use case finishes. 6.a: Patient updates wrong data values/file types. 6.a. 1: Software shows an error massage “Please correct the highlighted parameters.” 6.a.2: returns to step 4 at BS.

The “Update Health Data” use case allows patients to add their health parameters and fill in questionnaires to the software system. The pre-condition for this use case is that the user has already logged into their “Patient Area”. The basic scenario starts with the patient clicking on the "My Health Data" button, which takes them to a page where they can select the "Update New Health Data" button. The software system then displays the health parameters that can be updated, including heart rate, blood pressure, physical activity, sleep quality, weight, and glycemia. The system also presents the questionnaires that need to be filled up, such as Therapy Adherence and Patient Health Questionnaire.

Once the patient has updated their data, they click on the "save" button, and the software updates the health parameters. The system then displays a message saying "changes have done successfully." The software system also calculates and stores the scores related to the patient's questionnaire responses. After this, the use case finishes.

There is an alternative scenario where the patient wants to check their health data from previous records. In this scenario, the patient clicks on the "Previous health records" button and selects the desired date. The software system then shows the chosen records, and the use case finishes.

In case the patient updates wrong data values or file types, the software system shows an error message asking the patient to correct the highlighted parameters. Once the patient makes the necessary corrections, the system returns to step 4 on the basic scenario.

1.2.C Manage Booked Appointment

Tittle	**Manage booked appointment**
Description	Patient can see their appointment and determines its status
Actors	Patient, Software, Specialized practitioner
Pre-Condition	User has already logged in to “Patient Area”
Post-Condition	User has managed their appointment
Basic Scenario (BS)	1. Patient clicks on “My Appointments” button. 2. Software displays all appointments. 3. Patient selects specified appointment by specialized practitioner. 4. Patient confirms the appointment. 5. Software displays the message “The confirmation was successful.” 6. Software sends a notification message including the tracking code to both specialized practitioner and patient. 7. Software shows the optional button to add to “Personal Calendar.” 8. Use case finishes.
Alternative Scenario(s)	3.a: No appointment considered for the patient. 3.a. 1: Specialized practitioner has not specified an appointment for patient yet. 3.a.2: Use case finishes. 4.a.: Patient is not available for the considered appointment. 4.a.1: Patient asks for a change in time or date. 4.a.2: Software notifies Specialized practitioner. 4.a.3: Use case finishes. 4.b: Patient asks to cancel the appointment. 4.b.1: Patient clicks on “Cancel" button. 4.b.2: Software displays the message “ By confirming this operation, your therapy procedure will be stopped. Are you sure you want to continue?” 4.b.3: Software notifies specialized practitioner about the cancellation. 4.b.4: Use case finishes.

In this modeling and according to these types of diseases, we decided to consider thespecialized practitioner as the person who will book an appointment for the patient. Manage booked appointment possibility has been considered for unavailability of patient on thescheduled time and date by the specialized practitioner. In this case the patient can request a date & time change. This possibility can be done through the manage booked appointment partof program. The procedure of booking appointment has clearly explained in specialized practitioner part of this project.

The Manage Booked Appointment use case allows patients to view and manage their appointments in the “Patient Area” of the software system. The pre-condition for this use case is that the user has already logged into their “Patient Area”. The basic scenario starts with the patient clicking on the "My Appointments" button, which takes them to a page where they can see all of their appointments. Then, the patient selects a specified appointment by a specialized practitioner and confirms the appointment. Once confirmed, the software system displays a message saying, "The confirmation was successful." The system also sends a notification message, including a tracking code, to both the specialized practitioner and the patient.

the software system shows an optional button in case of adding the appointment to patient’s personal calendar then the use case will finish.

There are alternative scenarios where the patient may need to make changes or cancel the appointment. In case there is no appointment considered for the patient, the use case simply finishes. If the patient needs to change the date or time of the appointment, they ask for the change, and the software system notifies the specialized practitioner. Similarly, if the patient wants to cancel the appointment, they can click on the “cancel” button. The software system then displays a message asking the patient to confirm whether they want to continue with the cancellation. If the patient confirms, the system notifies the specialized practitioner about the cancellation, and the use case finishes.

1.2.D Manage Tickets

Tittle	**Manage Tickets**
Description	Patient can send a message to the specialized practitioner (about problems and questions related to prescriptions; side effects, question about a specific drug and, etc.) and technical administrator (about reporting a technical problem; requesting a new password, having a problem with logging in and, etc.) in order to communicate with them.
Actors	Patient, Software, Specialized practitioner, technical administrator
Pre-Condition	User has already logged in to "Patient Area"
Post-Condition	User has sent/received their tickets
Basic Scenario (BS)	1. Patient clicks on "My Tickets" button. 2. Patient clicks "New Message" button. 3. Patient selects specialized practitioner as the receiver person. 4. Software displays the list of specialized practitioners. 5. Patient selects the aimed specialized practitioner. 6. Patient writes down the message in the corresponding box. 7. Patient clicks on "Send" button. 8. Software displays the message "Your ticket has been sent successfully." 9. Use case finishes.
Alternative Scenario(s)	2.a: Patient wants to visualize their messages. 2.a. 1: Patient selects the ticket wants to visualize. 2.a.2: Software displays the selected ticket. 2.a.3: Use case finishes. 2.b: Patient wants to reply to a ticket. 2.b.1: Patient selects the ticket that they want to reply. 2.b.2: Software displays the selected ticket. 2.b.3: Patient clicks on "Reply" button. 2.b.4: Return to step 6 at BS.

	3.a: Patient wants to send a ticket to technical administrator. 3.a. 1: Patient selects technical administrator as the receiver person. 3.a.2: Software displays the list of technical administrators. 3.a.3: Patient selects the aimed technical administrator. 3.a.4: Return to step 6 at BS.

The “Manage Tickets” use case allows patients to communicate with specialized practitioners or technical administrators regarding problems and questions related to prescriptions, side effects, specific drugs, technical issues, passwords, etc. The pre-condition for this use case is that the user has already logged in to their “Patient Area”. The basic scenario starts with the patient clicking on the "My Tickets" button, which takes them to a page where they can see all of their tickets. Then, the patient clicks on the "New Message" button to create a new ticket. They select the specialized practitioner as the receiver person, and the software displays the list of specialized practitioners available. The patient the selects the intended practitioner and writes the message in the corresponding box. Once done, the patient clicks on the "Send" button. The software system displays a message saying "Your ticket has been sent successfully," and the use case finishes.

There are alternative scenarios when the patient wants to visualize their messages; they click on the ticket they want to view, and the software displays the selected ticket. If the patient wants to reply to a ticket, they select the ticket they want to reply to, and the software displays the selected ticket. The patient then returns to Step 6 in the Basic Scenario.

Another alternative scenario is when the patient needs to send a ticket to the technical administrator. In this case, the patient selects the technical administrator as the recipient person, and the software displays the list of technical administrators available. The patient selects the intended administrator and proceeds to Step 6 in the Basic Scenario.

1.3 Specialized Practitioner Textural Description

1.3.A Manage My Profile

Tittle	**Manage My Profile**
Description	Specialized Practitioner can observe/modify their profile information.
Actors	Specialized practitioner, Software
Pre-Condition	Specialized practitioner has already logged in to "Specialized practitioner area"
Post-Condition	Specialized practitioner has observed his/her profile.
Basic Scenario (BS)	1. Specialized practitioner clicks on "My Profile" button. 2. Specialized practitioner observes their data: A) Personal data: • Name • Surname • Gender • Codice Fiscale • Date of Birth • Place of Birth • Email • Spoken Language(s) • Profile Photo (.jpg) B) Professional data: • Habilitation number • Educational certificate image (.jpg) • Office Address • Office telephone number 3. Use case finishes.
Alternative Scenario(s)	2.a: Specialized practitioner wants to modify their data. 2.a. 1: Specialized practitioner clicks on "Edit" button 2.a.2: Specialized practitioner enters new value for fields which must be edited. 2.a.3: Specialized practitioner clicks on the "Save" button. 2.a.4: Software pops up the confirmation message "Are you sure?" 2.a.5: Software updates the new value after Specialized practitioner's confirmation.

	2.a.6: Software shows the message” Changes have saved successfully"

The “Manage My Profile” use case allows specialized practitioners to observe and modify their personal and professional information. The pre-condition for this use case is that the specialized practitioner has already logged in to their specialized practitioner area. The basic scenario starts with the specialized practitioner clicking on the "My Profile" button, which takes them to a page where they can see all of their profile information. Then, the specialized practitioner observes their data, including personal data such as name, surname, gender, codice fiscale, date of birth, place of birth, email, spoken language(s), and profile photo (.jpg), and professional data such as habilitation number, educational certificate image (.jpg), office address, and office telephone number. Once done, the use case finishes.

There is an alternative scenario when the specialized practitioner wants to modify their data. In this case, the specialized practitioner clicks on the "Edit" button, which allows them to enter new values for fields that need to be edited. After entering the new value, the specialized practitioner clicks on the "Save" button. The software system then pops up a confirmation message asking if the specialized practitioner is sure about the changes. If confirmed, the software updates the new value and displays a message saying "Changes have been saved successfully."

1.3.B Set an appointment

Tittle	**Set an appointment**
Description	Specialized practitioner can set an appointment for their patient.
Actors	Specialized practitioner, Software, Patient
Pre-Condition	Specialized practitioner has already logged in to "Specialized practitioner area"
Post-Condition	Specialized practitioner has set an appointment
Basic Scenario (BS)	1. Specialized practitioner clicks on "New Appointment" button. 2. Specialized practitioner searches for a specific patient. 3. Software displays the search result(s). 4. Specialized practitioner selects the desired patient. 5. Software displays available time slots. 6. Specialized practitioner chooses a time slot. 7. Specialized practitioner clicks on "Save" button. 8. Software notifies the patient to confirm. 9. Patient confirms the appointment. (Refer to the table 1.C) 10. Software updates the status of booked appointment to "Confirmed". 11. Software sends a notification to Specialized practitioner and patient about appointment confirmation including a generated tracking code. 12. Use case finishes.
Alternative Scenario(s)	1.a: Specialized practitioner wants to check the booking list. 1.a. 1: Specialized practitioner clicks on "Booking List" button. 1.a.2: Software displays all appointments. 1.a.3: Use case finishes. 1.b: Specialized practitioner wants to determine the status of appointments which are requested by patient to be changed. 1.b.1: Specialized practitioner clicks on "Requests list" button. 1.b.2: Software displays all appointments waiting for rescheduling.

	1.b.3: Specialized practitioner selects a specific request. 1.b.4: Specialized practitioner clicks on “Reschedule” button. 1.b.5: Return to step 5 at BS. 5.a: No free time slot available. 5.a.1: Software displays “There is no available time slot”. 5.a.2: Special practitioner puts the patient into the waiting list. 5.a.3: Use case finishes.

In this model, we consider that the person who can set the appointment is the specialized practitioner, and the patient cannot book an appointment for themselves. However, it is obvious that the patient may not be available on the specified time and date; so, we decided to consider the confirmation step for patient to finalize the appointment procedure. It means that an appointment’s status will be change whenever both specialized practitioner and patient are agreeing on the date and time. In case patient is not free on scheduled time, they can ask the specialized practitioner to change the time. Also this possibility has been considered for patient to cancel their appointment.

The “Set an Appointment” use case allows specialized practitioners to set appointments for their patients. The pre-condition for this use case is that the specialized practitioner has already logged in to their specialized practitioner area. The basic scenario starts with the specialized practitioner clicking on the "New Appointment" button, which takes them to a page where they can search for a specific patient. Then, the specialized practitioner searches for the patient, and the software system displays the search result(s). The specialized practitioner selects the desired patient, and the software displays available time slots. Once done, the specialized practitioner chooses a time slot and clicks on the "Save" button. The software system then notifies the patient to confirm the appointment by sending them a notification message (Refer to Table 1.C). If the patient confirms the appointment, the software updates the status of the booked appointment to "Confirmed." The software also sends a notification to the specialized practitioner and the patient about the appointment confirmation, including a generated tracking code. Once done, the use case finishes.

There are alternative scenarios when the specialized practitioner wants to check the booking list or determine the status of appointments requested by the patient to be changed. In the first case, the specialized practitioner clicks on the "Booking List" button, and the software displays all the appointments. In the second case, the specialized practitioner clicks on the "Requests list" button, and the software displays all appointments waiting for rescheduling. The specialized practitioner can select a specific request and click on the "Reschedule" button, which takes them back to Step 5 in the Basic Scenario.

Another alternative scenario is when no free time slot is available. In this case, the software displays a message saying "There is no available time slot." The specialized practitioner then puts the patient on the waiting list, and the use case finishes.

1.3.C Visit

Tittle	**Visit**
Description	1) Specialized Practitioner visits a patient, analyzes the treatment process, and decides whether to prescribe, examine or do nothing. 2) Thresholds may change based on the Specialized practitioner's decision and the patient's condition or under the influence of drug side effects. 3) Specialized practitioner measure in-hospital parameters during the visit and enter them to software.
Actors	Specialized Practitioner, Patient, Software
Pre-Condition	User has already logged into “Specialized practitioner area”
Post-Condition	User has visited the patient.
Basic Scenario (BS)	1. Specialized practitioner clicks on “Visit” button. 2. Software shows “patient list”. 3. Specialized practitioner selects the desired patient who needs to be visited. 4. Specialized practitioner confirms the presence of the patient. 5. Software updates the status of the patient to “Present”. 6. Software displays the patient’s “health profile”. 7. Specialized practitioner clicks on “In-hospital parameters” button. 8. Specialized practitioner measures fallowing In-hospital parameters: A) Files type to be uploaded (.csv): • Heart Rate B) Manual data to be inserted • Supine blood presure • Standing Blood pressure • JVP (Jugular venous pressure) • Cardiac auscultation • Blood exam result • Medical reports 9. Specialized practitioner enters collected parameters. 10. Specialized practitioner clicks on “Save” button.

	11. Software updates In-hospital parameters. 12. Specialized practitioner asks for patient's health parameters. 13. Software displays at-home and in-hospital parameters and compares with standard threshold. 14. Specialized practitioner prescribes for the patient and enters it into the system. The prescription can include: a. drug prescription b. asks for an examination. c. referring the patient to another physician. 15. Software saves the prescription. 16. Specialized practitioner prints the hard copy of the prescription. 17. Specialized practitioner signs and seals the printed prescription. 18. Specialized practitioner sets the next appointment. (Refer to the table 2.B) 19. Specialized practitioner changes the status of the appointment to "Completed". 20. Software updates the appointment status. 21. Use case finishes.
Alternative Scenario(s)	4.a: Patient is absent. 4.a.1: Specialized practitioner notifies the system that the patient is absent. 4.a.2: Software changes the status of appointment to "Cancelled". 4.a.3: Software sends a notification to the patient about cancellation. 4.a.4: Use case finishes. 13.a: Specialized practitioner wants to change the thresholds. 13.a.1: Specialized practitioner selects the specific parameter. 13.a.2: Specialized practitioner sets a new threshold. 13.a.3: Software saves the new threshold and provides the specialized practitioner with the new comparison. 14.a: No prescription needed.

	14.a.1: Specialized practitioner diagnoses that the patient does not need a prescription. 14.a.2: Return to step 18 at BS. 18.a: Patient does not need a new appointment.

The “Visit” use case involves a specialized practitioner visiting a patient, analyzing the treatment process, and deciding whether to prescribe medication, request an examination, or do nothing. The pre-condition for this use case is that the user has already logged in to their “specialized practitioner area”. The basic scenario starts with the specialized practitioner clicking on the "Visit" button, which takes them to a page where they can see the “patient list”. Then, the specialized practitioner selects the desired patient who needs to be visited and confirms the patient's presence. Once done, the software updates the patient's presence status. Next, the specialized practitioner checks data from the patient's health data section, and the software displays all submitted health parameters with comparison to the standard thresholds.

After observing the data, the specialized practitioner prescribes medication, requests an examination, or refers the patient to another physician, based on their decision and the patient's condition or drug side effects. The software saves the prescription, and the specialized practitioner prints a hard copy of the prescription. They sign and seal the printed prescription and set the next appointment (Refer to Table 2.B). Once done, the specialized practitioner changes the status of the appointment to "Completed," and the software updates the appointment status. The use case finishes.

There is an alternative scenario when the patient is absent. In this case, the specialized practitioner notifies the system that the patient is absent. The software changes the status of the appointment to "Cancelled" and sends a notification to the patient about cancellation. In case the specialized practitioner wants to change the thresholds, they can select the specific parameter, set a new threshold, and the software saves the new threshold and provides the specialized practitioner with the new comparison. If no prescription is required, the specialized practitioner diagnoses that the patient does not need a prescription, and the use case returns to Step 12 in the Basic Scenario. If the patient does not need a new appointment, the use case finishes.

1.3.D Manage Tickets

Tittle	**Manage Tickets**
Description	Specialized practitioner can send a message to the Patient (ask for some necessary information or a health report) and technical administrator (about reporting a technical problem; requesting a new password, having a problem with logging in and, etc.) in order to communicate with them.
Actors	Specialized practitioner, Patient, Software, Technical administrator
Pre-Condition	User has already logged in to "Specialized practitioner Area"
Post-Condition	User has sent/received their tickets
Basic Scenario (BS)	1. Specialized practitioner clicks on "My Tickets" button. 2. Specialized practitioner clicks "New Message" button. 3. Specialized practitioner selects Patient as the receiver person. 4. Software displays the list of patients. 5. Patient selects the aimed patient. 6. Specialized practitioner writes down the message in the corresponding box. 7. Specialized practitioner clicks on "Send" button. 8. Software displays the message "Your ticket has been sent successfully." 9. Use case finishes.
Alternative Scenario(s)	2.a: Specialized practitioner wants to visualize their messages. 2.a. 1: Specialized practitioner selects the ticket wants to visualize. 2.a.2: Software displays the selected ticket. 2.a.3: Use case finishes. 2.b: Specialized practitioner wants to reply to a ticket. 2.b.1: Specialized practitioner selects the ticket that they want to reply. 2.b.2: Software displays the selected ticket. 2.b.3: Specialized practitioner clicks on "Reply" button.

	2.b.4: Return to step 6 at BS. 3.a: Specialized practitioner wants to send a ticket to technical administrator. 3.a.1: Specialized practitioner selects technical administrator as the receiver person. 3.a.2: Software displays the list of technical administrators. 3.a.3: Specialized practitioner selects the aimed technical administrator. 3.a.4: Return to step 6 at BS.

The “Manage Tickets” use case allows specialized practitioner to communicate with their patients or technical administrator by sending messages about patients’ health situation, communicate necessary information, technical problems, passwords, logging in and etc. The pre-condition for this use case is that the user has already logged in to their “specialized practitioner Area”. The basic scenario starts with the specialized practitioner clicking on the "My Tickets" button, which takes them to a page where they can create a new message. Then, the specialized practitioner selects the “patient” as the receiver, and the software displays the list of patients. Once done, the specialized practitioner selects the aimed patient and writes down the message in the corresponding box. After composing the message, the specialized practitioner clicks on the "Send" button, and the software displays the message "Your ticket has been sent successfully." Once done, the use case finishes.

There are some alternative scenarios for this part. Firstly, when the specialized practitioner wants to visualize their messages, they select the ticket they want to check, and the software displays the aimed ticket. If the specialized practitioner wants to reply to a ticket, after selecting the preferred ticket, they select the “Reply” bottom. Then use case will return to Step 6 in the Basic Scenario. For the case in which the specialized practitioner needs to send a ticket to the technical administrator, they choose the “technical administrator” as the receiver. The software then displays the “Technical administrator list”. Subsequently, specialized practitioner selects a specific technical administrator, and finally the use case returns to Step 6 in the Basic Scenario.

1.4 Technical Administrator

1.4.A Manage Users

Tittle	**Manage Users**
Description	Technical administrator can manage some operations related to the users including: creation of a new user, edit personal information of users, and delete a user.
Actors	Technical administrator, Software
Pre-Condition	User has already logged in to "Technical management area"
Post-Condition	User has edited the personal information of a user.
Basic Scenario (BS)	1. Technical administrator clicks on "Manage Users" button. 2. Software displays "all users list". 3. Technical administrator searches for a specific user. 4. Technical administrator selects a user among search results. 5. Software displays the user's personal information. 6. Technical administrator modifies the desired fields. 7. Technical administrator clicks on the "Save" button. 8. Software shows the message "Are you sure you want to continue?". 9. Technical administrator confirms. 10. Software saves the changes. 11.Use case finishes.
Alternative Scenario(s)	3.a: Technical administrator wants to create a new user. 3.a. 1: Technical administrator clicks on "create a new user" button. 3.a.2: Technical administrator selects "user type". 3.a.3: Software displays corresponding information module according to the user type. 3.a.4: Technical administrator fills in all required fields of the module. 3.a.5: Technical administrator clicks on "Save" button. 3.a.6: Software creates the new user in the system.

	3.a.7: Use case finishes. 3.b: User not found. 3.b.1: Software cannot find the user in the database. 3.b.2: Use case finishes. 6.a: Technical administrator wants to delete the user. 6.a. 1: Technical administrator clicks on “Delete User” button. 6.a.2: Software shows the message “Are you sure you want to continue?” 6.a.3: Technical administrator confirms. 6.a.4: Software deletes the user from the database and updates users list. 6.a.5: Use case finishes.

According to the “Manage Users” use case, the technical administrator can manage users in the platform. This act involves the creation of a new user, editing personal information of users,and deleting a user. The pre-condition for this use case is that the user has already logged in totheir technical management area. Beginning the basic scenario with the technical administrator clicking on the "Manage Users" button, which takes them to a page where they can see all the users' list (including specialized practitioners and patients list). Then, the technical administrator searches for a specific user and selects a user among the search results. Once done, the software displays the user's personal information, and the technical administrator modifies the desired fields. After modifying the fields, the technical administrator clicks on the "Save" button, and the software shows the message "Are you sure you want to continue?" If the technical administrator confirms, the software saves the changes, and the use case finishes.

As an alternative scenario, When the technical administrator wants to create a new user, they select the user type, and then the software displays corresponding information modules according to the user type. following the filling of all required fields of the module, technical administrator clicks on the "Save" button, and the software creates the new user, and finally the use case finishes. Another alternative scenario occurs when the user is not found. In this case, the software cannot find the user in the database, and the use case finishes.

Other possible alternative scenario is when the technical administrator wants to delete the user. In this case, the technical administrator clicks on the "Delete User" button, and the software shows the message "Are you sure you want to continue?" If the technical administrator confirms, the software deletes the user and updates the users' list, and the use case finishes.

1.4.B Backup

Tittle	**Backup**
Description	Each system requires to be backed up in order to ensure safety and security, and to be protected from potential technical problems. Certainly, patients' information are confidential between patient and specialized practitioner and no other users should have access to them. In order to apply this condition, software provides technical administrator with an encrypted version of files.
Main Actor	Technical administrator, Software
Pre-Condition	User has already logged in to "Technical management area"
Post-Condition	User has backed up the data
Basic Scenario (BS)	1. Technical administrator clicks on "Backup" button. 2. Software opens a window containing the message. "Which files do you want to back up?" 3. Technical administrator selects personal information to be backed up. 4. Software provides an encrypted backup file to be saved. 5. Software asks for the location for the data to be stored. 6. Technical administrator specifies file location and clicks on "Save" button. 7. Use case finishes.
Alternative Scenario(s)	3.a: The data are not personal information. 3.a.1: Technical administrator selects user's EMR to be backed up. 3.a.2: Return to step 4 at BS.

The "Backup" process leads to a higher safety, security, and protection against potential technical problems. It also ensures that patients' medical information remains confidential between the patient and specialized practitioner, and no other users should have access to them. The pre-condition is that the user has already logged into their "Technical Management Area". The main success scenario starts with the technical administrator clicking on the "Backup" button, which opens a window containing the message "Which files do you want to back up?" Then, the technical administrator selects the users' personal data that needs to be backed up. The software then asks for the location where the encrypted file should be stored, and the

technical administrator specifies the file location and clicks on the "Save" button. Once done, the use case finishes.

In the alternative scenario in which the data are not personal information, the technical administrator chooses the user's electronic medical record to be backed up, and the software provides an encrypted backup file to be saved. The use case then returns to Step 5 in the main success scenario.

1.4.C Manage Tickets

Tittle	**Manage Tickets**
Description	Technical administrator can send a message to inform all users about software updates, extraordinary maintenance, andsystem unavailability in a specific time. Also, Technical administrator can reply to users' requests through the tickets such as generating new password, username, solving theirtechnical problems etc.
Actors	Technical administrator, Specialized practitioner, Patient, Software
Pre-Condition	User has already logged in to "Technical administrator Area"
Post-Condition	User has sent/received their tickets
Basic Scenario (BS)	1. Technical administrator clicks on "My Tickets" button. 2. Technical administrator clicks "New Message" button. 3. Technical administrator selects Patient as the receiver person. 4. Software displays the list of patients. 5. Technical administrator selects the aimed patient. 6. Technical administrator writes down the message in the corresponding box. 7. Technical administrator clicks on "Send" button. 8. Software displays the message "Your ticket has been sent successfully." 9. Use case finishes.
Alternative Scenario(s)	2.a: Technical administrator wants to visualize their messages. 2.a. 1: Technical administrator selects the ticket wants to visualize. 2.a.2: Software displays the selected ticket. 2.a.3: Use case finishes. 2.b: Technical administrator wants to reply to a ticket. 2.b.1: Technical administrator selects the ticket that they want to reply. 2.b.2: Software displays the selected ticket. 2.b.3: Technical administrator clicks on "Reply" button.

	2.b.4: Return to step 6 at BS. 3.a: Technical administrator wants to send a ticket to specialized practitioner. 3.a. 1: Technical administrator selects specialized practitioner as the receiver person. 3.a.2: Software displays the list of specialized practitioners. 3.a.3: Technical administrator selects the aimed specialized practitioner. 3.a.4: Return to step 6 at BS.

The use case of “Manage tickets” allows the technical administrator to reply to some technical problems that may occur for users and send messages to users about potential unavailability of the system due to software updates or technical issues. The pre-condition for this use case is that the user has already logged in to their “Technical Management Area”. The basic scenario starts with the technical administrator clicking on the "My Tickets" button. After the selection of "New Message" button, technical administrator clicks on “Patient ” as the receiver to write their message to the patient. After which, the technical administrator clicks on the "Send" button, and the software displays the message "Your ticket has been sent successfully." Once done, the use case finishes.

When the technical administrator does not want to send a message and just want to visualize their previously sent/received tickets, they select a specific ticket to read. In the case that technical administrator wants to reply to a ticket, they should select a specific ticket, followed by choosing “reply”. Another alternative scenario occurs when the technical administrator wants to send a ticket to the specialized practitioner. In this case, the technical administrator chooses "specialized practitioner" as the receiver and writes down their massage. The next steps, occurs as in the Basic Scenario.

2. Use Case Diagrams

2.1 Patient Use Case Diagram

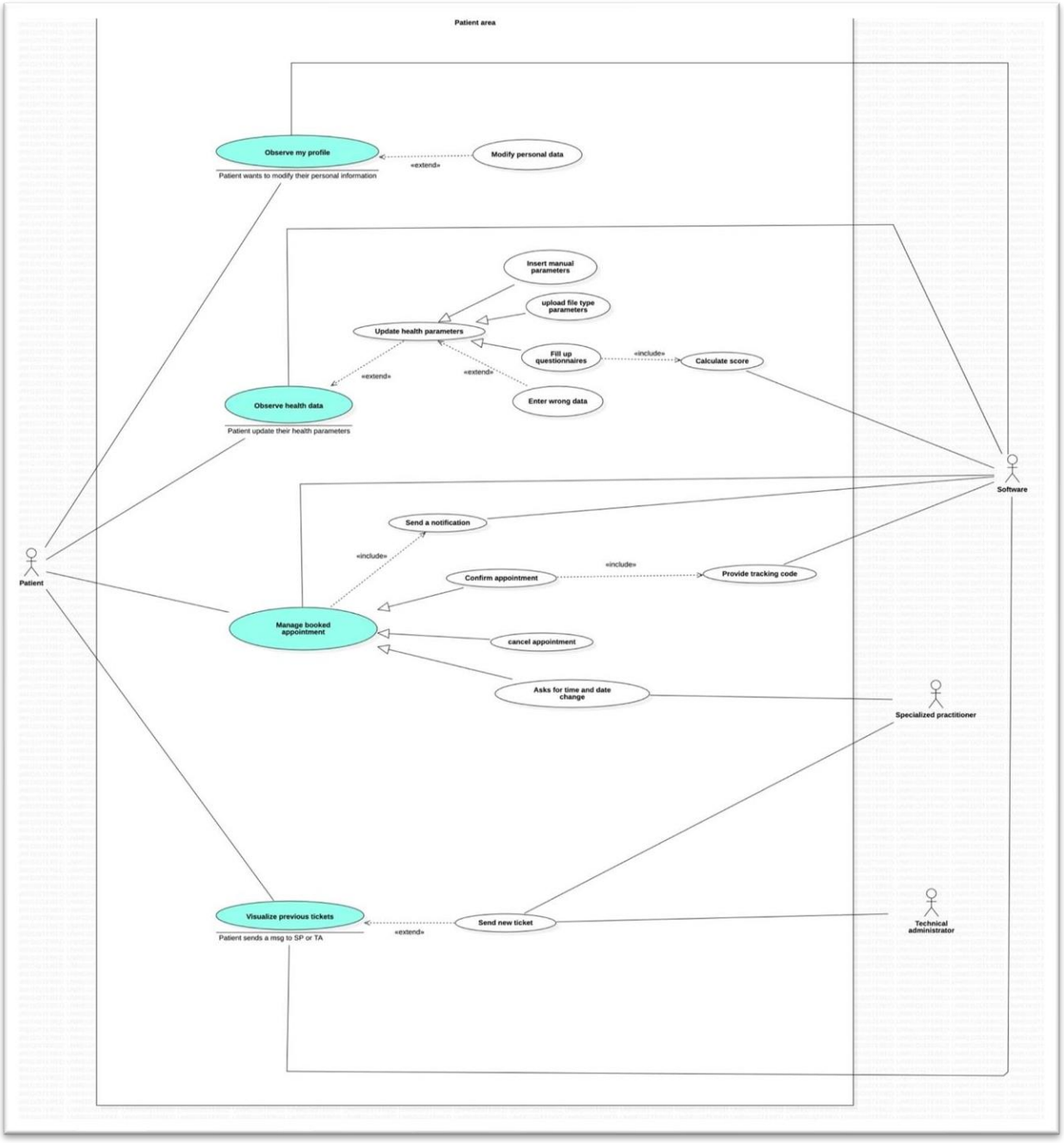

Figure 2: "Patient" Use case diagram

File type of this diagram is available. To download, please click on the icon.

In this diagram, the use case of ‘’Patient” has been drawn. There is 4 main action lines which are for observing the profile and the health data, managing booked appointments, and visualizing previous tickets. During the observation of profile and health data, there is the possibility to modify data which are considered as extends of the main use cases. Regarding the manage booked appointments, the patients are also able to confirm, cancel or change their visit sessions which in case of later, the software will provide a tracking code both for patient and specialized practitioner. Patient is also able to check their previous ticket or send new ticket not only to specialized practitioner but also technical administrator.

2.2 Specialized Practitioner Use Case Diagram

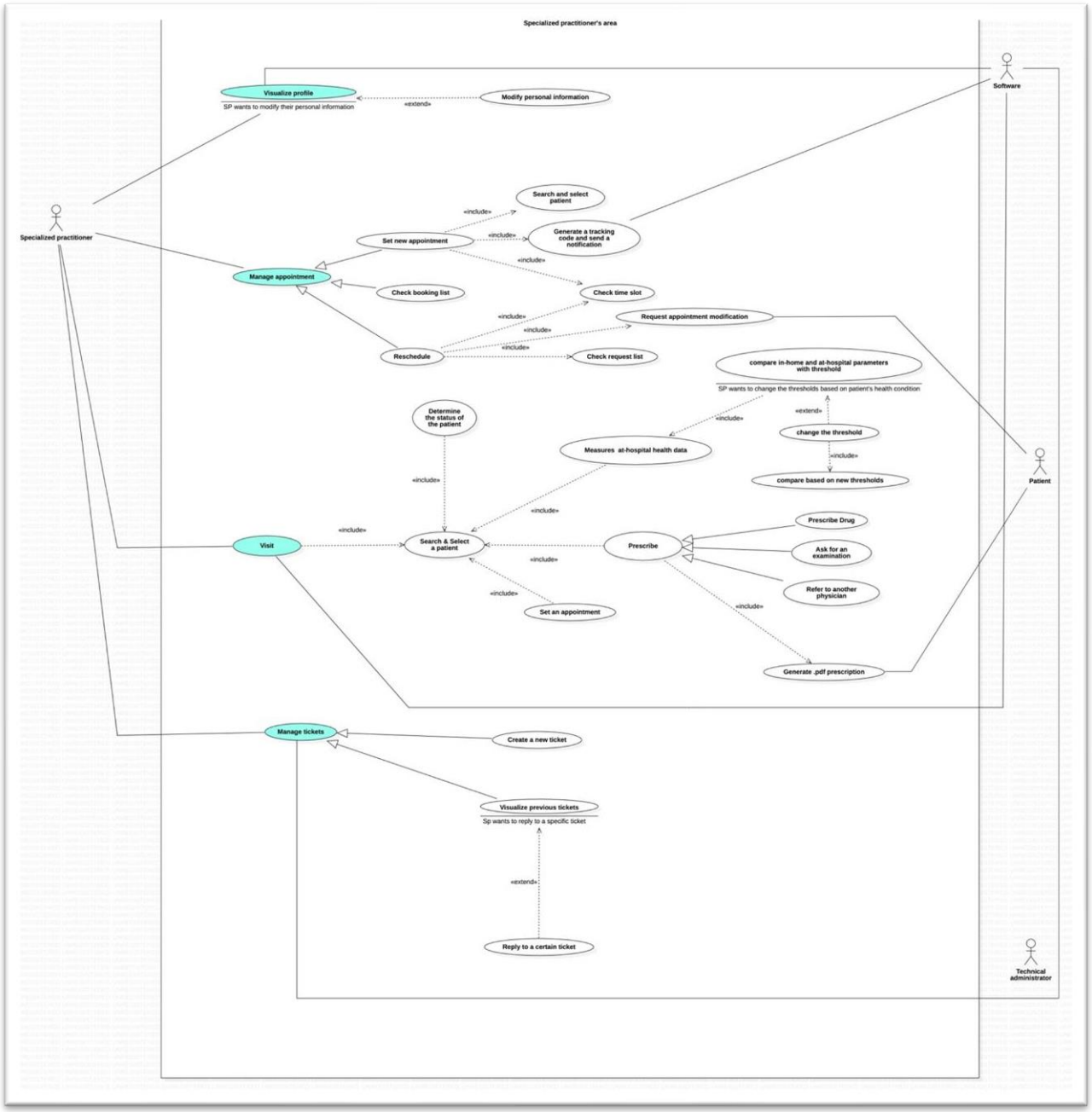

Figure 3: “Specialized practitioner” use case diagram

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The Specialized practitioner use case diagram consist of 4 main actor lines including visualize profile, manage appointments, visit, and manage tickets.

Modifying personal information is possible during checking the profile which is considered as an extension in the first actor line. Managing the profile consists of setting a new appointment,

checking the booking list, and rescheduling. The Software by generating a tracking code, provide a tool for a better access to the appointment process.

Through the visit session, following the search and selection of a patient, there are several use cases such as determining the status of a patient, measuring at-hospital health data, prescription and setting a new appointment.

It’s worth to mention that, after the measurement of at-hospital health data, the software compares in-home and at-hospital parameters together with standard thresholds. However, In some cases, according to the patient’s health condition, thresholds need to be changed. Therefore, a new comparison between parameters should be provided.

Like all the other users, specialized practitioner can manage their tickets which includes creation of a new ticket to be send to technical administrator and the patient, visualizing their previous tickets as well as replying to a specific ticket if needed.

2.3 Technical Administrator Use Case Diagram

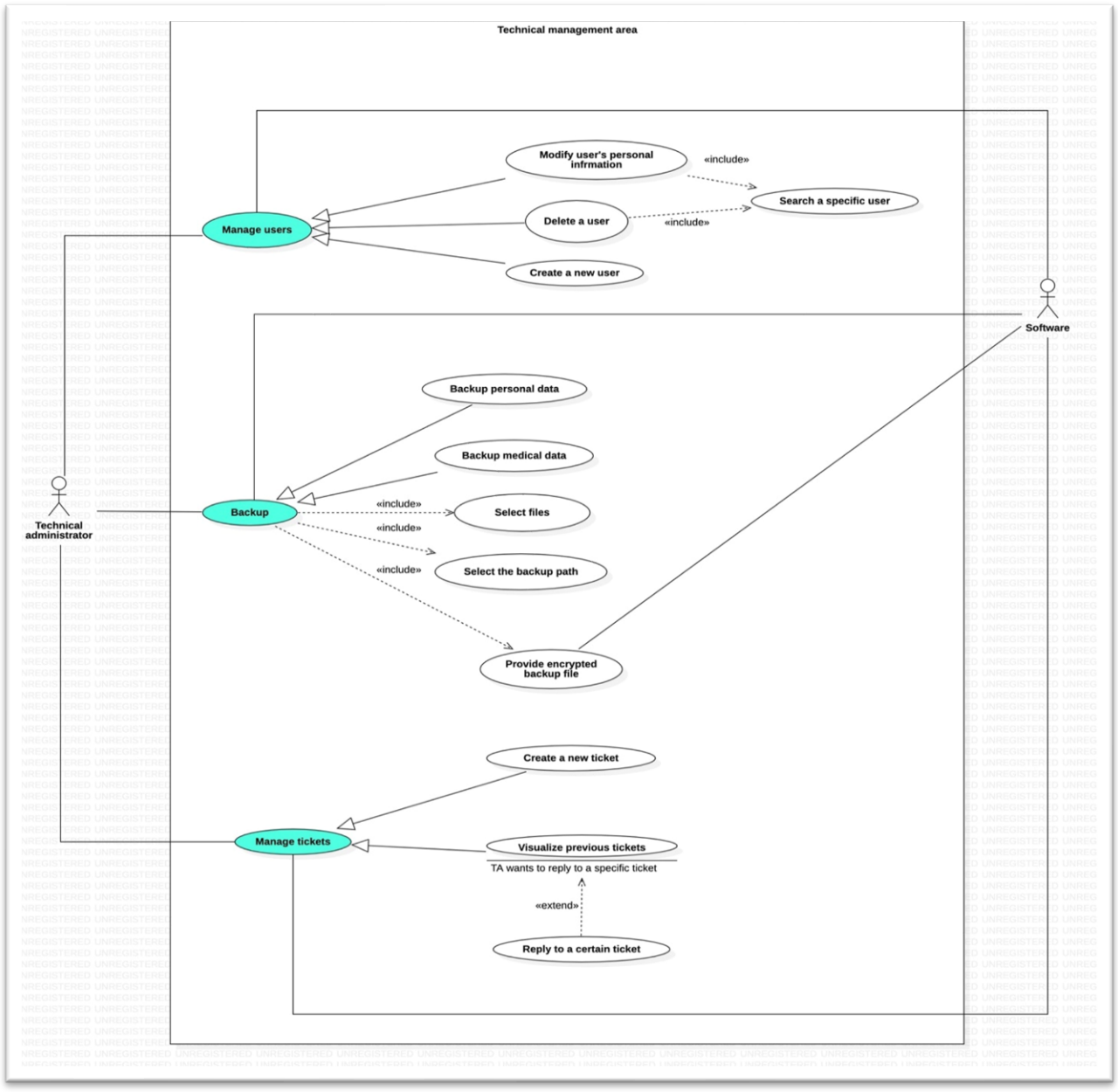

Figure 4: "Technical administrator" use case diagram

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The last use case to be explained is about technical administrator which contains 3 main paths of action: managing the users, backup and managing tickets. Technical administrator is able to create and delete users while having the possibility to modify their personal information with their access to the software. To avoid losing the important data about the patients, the software enables getting the backup not only from the personal data but also medical information available in the system in form of encrypted files. Managing the tickets procedure is the same as all the other users which previously explained in detail.

3. Activity Diagrams

3.1 *Login Activity Diagram for all users

Login is a mutual activity among all users and being logged in is a pre-condition for every other activities. In order to perform login, firstly, the software displays the login page. This leads to two situations; the user can or cannot remember their username and password. In case the user cannot remember, they click on the “Password recovery” button and the software displays the recovery page. By this, the user is able to enter their recovery email and click on the “Send a recovery request” button. The final step in this situation is that the software sends the request to the technical administrator. When it comes to the second situation in which the user can remember, they enter their username and password and click on the “Login” button. If the user insert the password and username correctly, the software displays the user area and activity finishes but if they insert incorrectly, the software displays the ”The username or password is wrong” message and the activity returns to the initial point of activity.

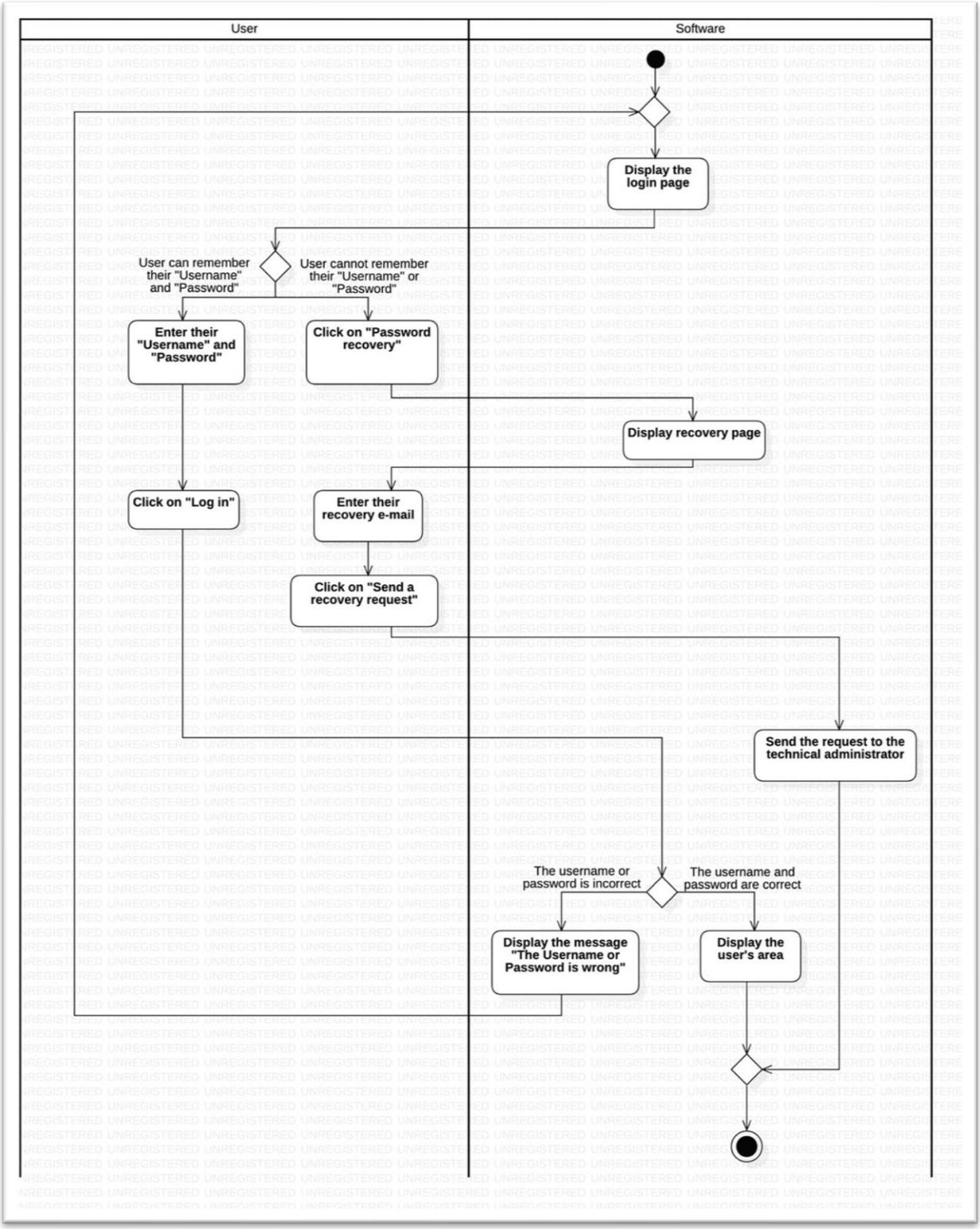


Figure 5: Login Activity Diagram for All Users

File type of this diagram is available. To download, please click on the icon.

3.2 Manage Tickets Activity Diagram for all users

In the “Manage Tickets” Activity diagram, user (which can be Patient, Special Practitioner, or Technical Administrator), interacts with the software regarding their problems and questions. The pre-condition for this activity diagram is that the user has already logged in to their personal area. To begin with, the user clicks on the "My Tickets" button, which takes them to a page where they can see all their tickets. Here, the user has two options to do;

1) If the user wants to create a new ticket, they will click on the "New Message" button. It will result in two options for the user which will let them to decide between user type A or B to send the message (*). Then, the software will show a list of users according to the selected type, after which, the user can select a specific user through the list. In the next step, user will write their message and send it by clicking on the “Send” button which is followed by the ”Your message has been sent successfully” message from the software and the activity finishes.
2) The second option after clicking “My Tickets” button is that the user wants to read a specific ticket, for which, they need to select it. Consequently, the selected ticket will be displayed by the software. In this stage, the user can either make a reply on it or just read (visualize) the ticket and activity finishes (In case of making a reply, the user should follow the aforementioned steps from writing their message to the end of operation).

(*) The table below illustrates the possible roles can be consider for user Type A and user Type B, due to the role of the main user who interacts with the software.

Sender	**Receiver**	
	Type A	**Type B**
Patient	Specialized practitioner	Technical administrator
Specialized practitioner	Patient	Technical administrator
Technical administrator	Patient	Specialized practitioner

Table 1: Map Table for Managing Tickets by All Users

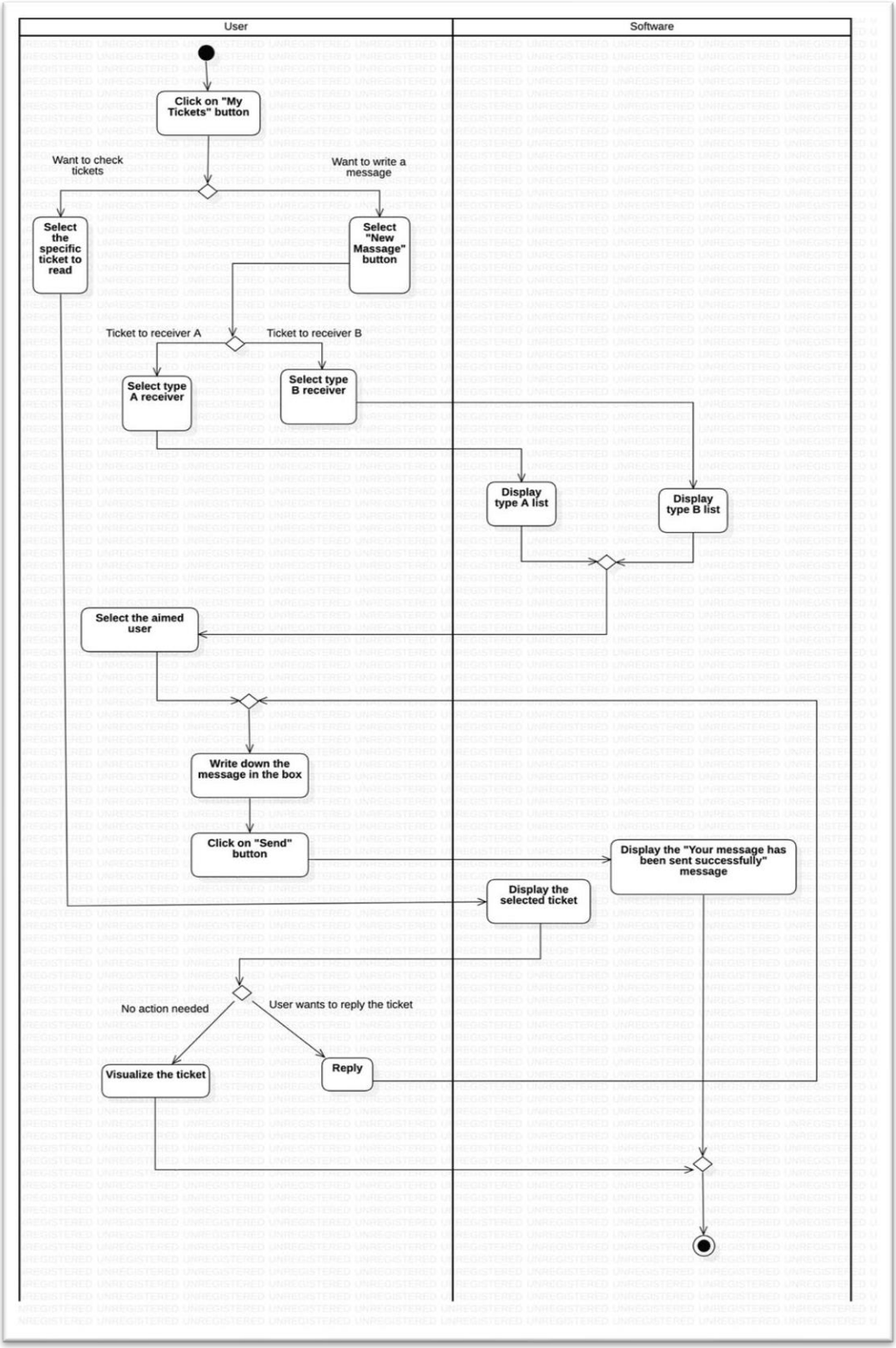


Figure 6: Manage tickets Activity Diagram for All Users

File type of this diagram is available. To download, please click on the icon.

3.3 Manage Appointments Activity Diagram for Patients & Specialized Practitioner

Manage appointment is an activity consisted of three users; Specialized practitioner (SP), software, and patient. In the beginning, by clicking on the "Manage appointment" button, the SP confronts with three options; SP wants to schedule a new appointment for a patient, SP wants to visualize the booking list, and SP wants to reschedule time slots for the patient waiting for a date change. For the first option, the SP needs to click on the "Set a new appointment" button and search for a specific patient. Then, the software displays the search result and the SP selects the desired patient. Consequently, the software displays available time slots. In this case, there are two situations available; there exists at least one available time slot or no available time slot at all to be allocated. For the **former**, the software displays available time slots, the SP chooses the time slot, and clicks on the "Save" button. In the next step, the software notifies the patient to confirm. After this, the patient can (1) confirm, (2) request to cancel or (3) request to change the appointment.

1) In case of cancellation, the patient should click on the "Cancel" button so that the software pop up the confirmation operation. By clicking on the "Confirm" button, patient is sure about their decision and the software deletes the appointment, updates the time slots, and activity finishes. However, if the patient has given up on their decision, they need to click on "Cancel" button and this brings them to where the patient confronts with options (1), (2), and (3).
2) In case the patient wants to change the appointment date, they have to ask for a date change. Then, the software notifies the SP about this and the SP can allocate new time slots. Repeatedly, available time slots are displayed by the software.
3) In case the patient confirms the appointment, the software displays the successful confirmation message. Accordingly, the software sends a notification message including the tracking code to both the patient and SP and shows the "Add to personal calendar" message. As a result, the activity finishes.

For the **latter**, the software displays no available time slots and puts the patient on the waiting list and the activity finishes.

By going back to the beginning of our activity diagram where the SP had three options, if the SP wants to visualize the booking list, the software displays the appointment list and the activity finishes.

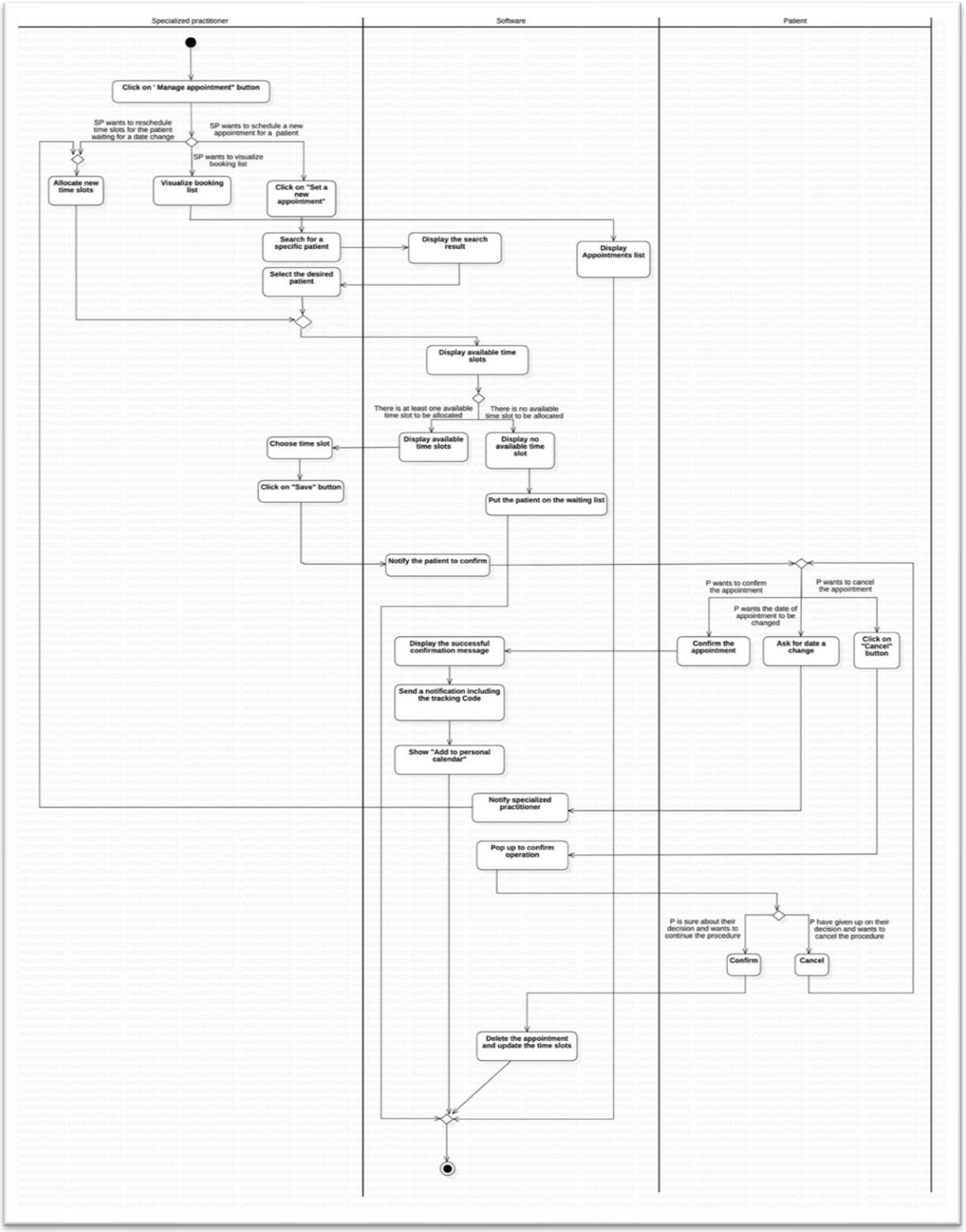


Figure 7: Manage Appointments Activity Diagram for Patients & Specialized Practitioner

File type of this diagram is available. To download, please click on the icon.

3.4 Save Health Data Activity Diagram for Patients

Considering that the patient has already logged in, they click on “My health data” button. By entering the mentioned area, the patient has two options; (1) to save health data or (2) to visualize their health data.

1) If the patient wants to save their health data, first of all, the patient clicks on the “Upload new health data” button and followed by this, the software displays their health parameters (File types to be uploaded, Manual data to be inserted, and Questionnaires to be filled in). By this, the patient can update the desired data and click on the “Save” button. After this, there exist two scenarios; the updated data values or file types can be right or wrong. In the wrong case, the software shows an error message, and the patient is directed to update their data all over again. On the other hand, if the updated data are right, the software updates the health parameters. Then, showing the successful change message, software calculates the questionnaires’ score. Finally, the software stores the calculated scores and the activity finishes.
2) However, if the patient wants to visualize their health data, they just need to click on the “Previous health records” button. After this, the patient chooses their desired date and software shows the chosen records. This is how the activity finishes.

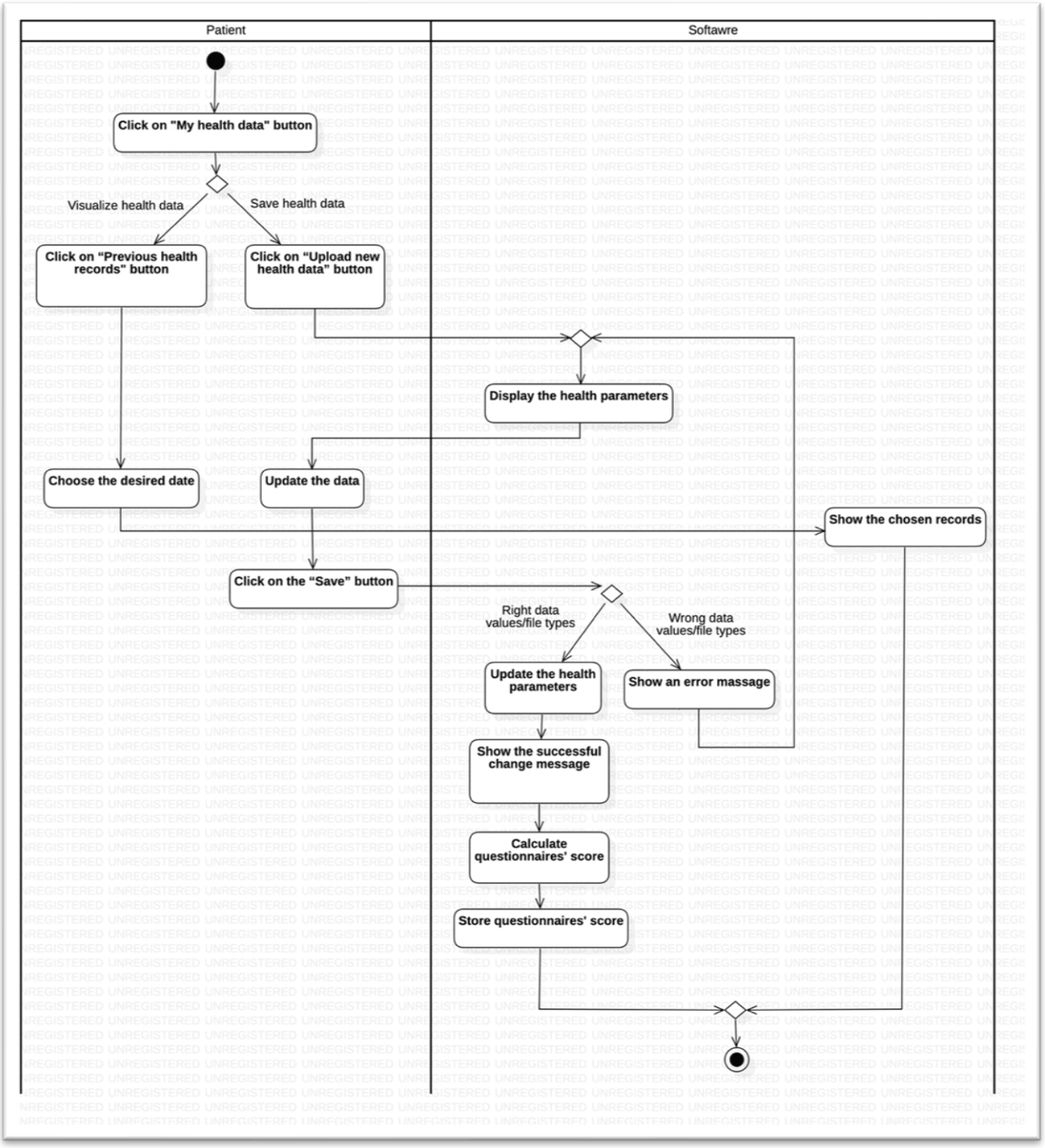


Figure 8: Save Health Data Activity Diagram for Patients

File type of this diagram is available. To download, please click on the icon.

3.5 Visit Activity Diagram for Specialized Practitioner

There are two actors participating in the “Visit” activity diagram: the specialized practitioner (SP) and the software. The in-person visit session starts with the SP clicking on the “Visit” button on their system. By doing this, the software shows patient list, from which, the SP can select the desired patient needing to be visited. In this stage, there are two possibilities; the patient is (1) absent or (2) present.

(1) In case the patient is present, the SP has to confirm the presence of patient, and once this happened, the software updates the status of the appointment to “Present” with displaying the health profile of the patient. After all these, the SP can now click on the “in-hospital parameters” button, and after measuring them, the SP is possible to enter both the file type and the manual parameters. In order to save the changes, the SP needs to click on the “Save” button, after which the software updates the entered in-hospital parameters. Once the SP asks for showing all the parameters, the software displays them with comparing to the thresholds and this makes the SP able to visualize the parameters together with the comparison. In the next step, it is up to the SP to decide whether prescription is needed or not. If prescription is not needed, the SP sets the next appointment, but if prescription is needed, the SP prescribes and submits it in the system, so that the software can save the prescription. In this case, printing, signing, and sealing the hard copy of the prescription are the tasks which have to be done by the SP before setting the next appointment. Finally, the SP changes the status of the appointment to “Completed”, the software updates the appointment status, and the activity finishes.

(2) In the possibility of patient absence, the SP needs to report to the system that the patient is absent. Consequently, the software changes the status of the appointment to “Cancelled” and notifies the patient about cancellation. This is how the activity finishes.

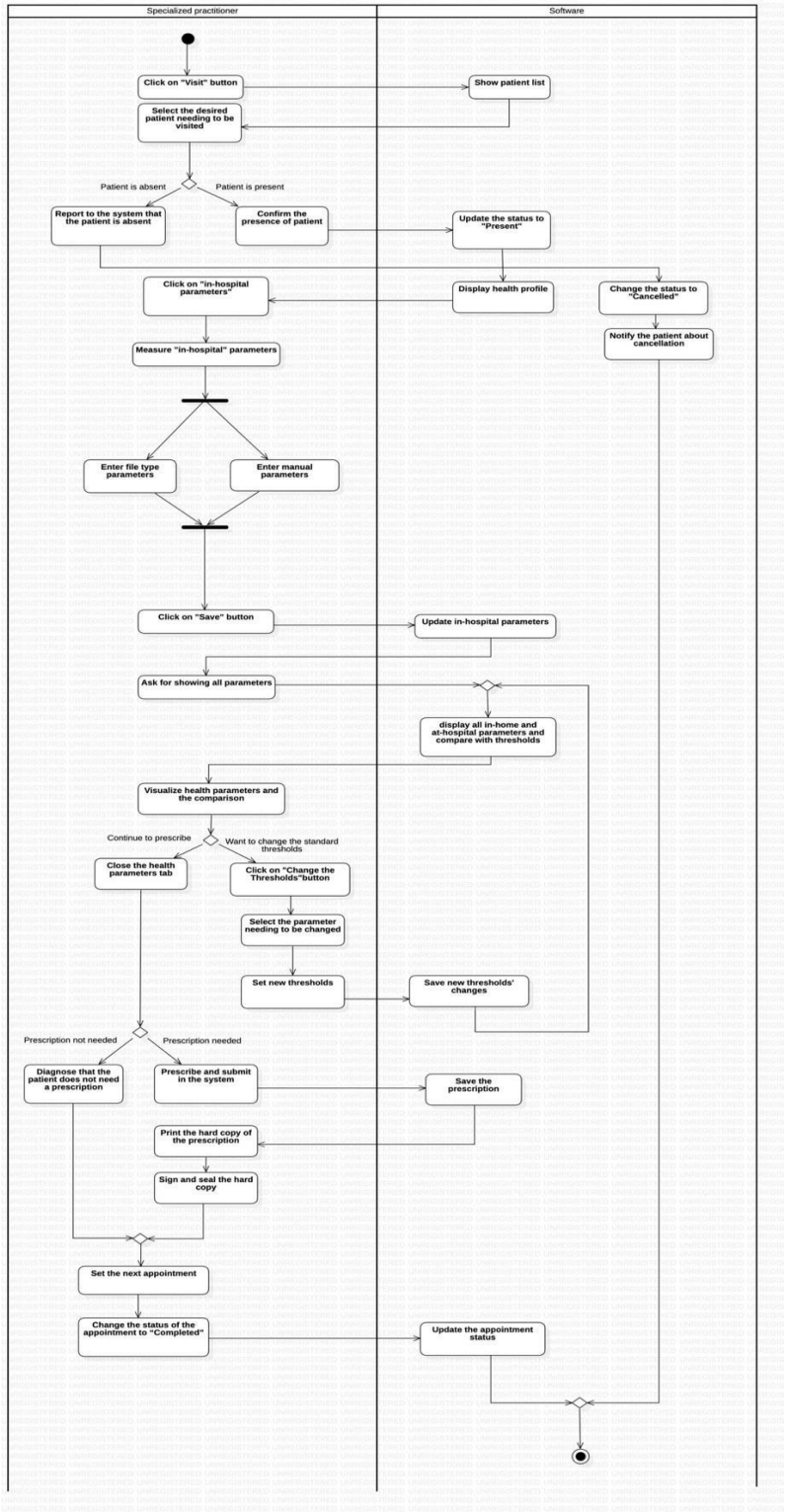


Figure 9: Visit Activity Diagram for Specialized Practitioner

File type of this diagram is available. To download, please click on the icon.

3.6 Manage Users Activity Diagram for Technical Administrator

Since sometimes the technical administrator needs to manage users, they click on “Manage Users” button. The software displays users list and the technical administrator can choose between creating a new user and searching for a specific user. If the technical administrator searches for a specific user, the software displays the search result. This can end into two options; the user is found or not found in the search result. In case the user is found, the technical administrator selects the user and the software displays the user’s personal information. The next step for the technical administrator is to choose between these options; to delete a user or to modify a user. For the former, the technical administrator clicks on the “Delete User” button and for the latter, they modify the desired fields and click on the “Save” button. These two options both cause the software to display the “Are you sure to continue?” message. In response to this message, if the technical administrator wants to cancel the procedure, they will be brought back to where the software displays user’s personal information. However, if the technical administrator confirms the procedure, the software saves the changes and updates the system and the activity finishes. Going back to where the user was not found by searching, the software displays the ” User not found” message and activity finishes. Referring to the option in which the technical administrator wants to create a new user, they click on the “Create new user” button and select user type. Then, the software displays corresponding information module, the technical administrator fills in the module and clicks on the “Save” button. All these actions result in where the software adds the new user to the system and the activity finishes.

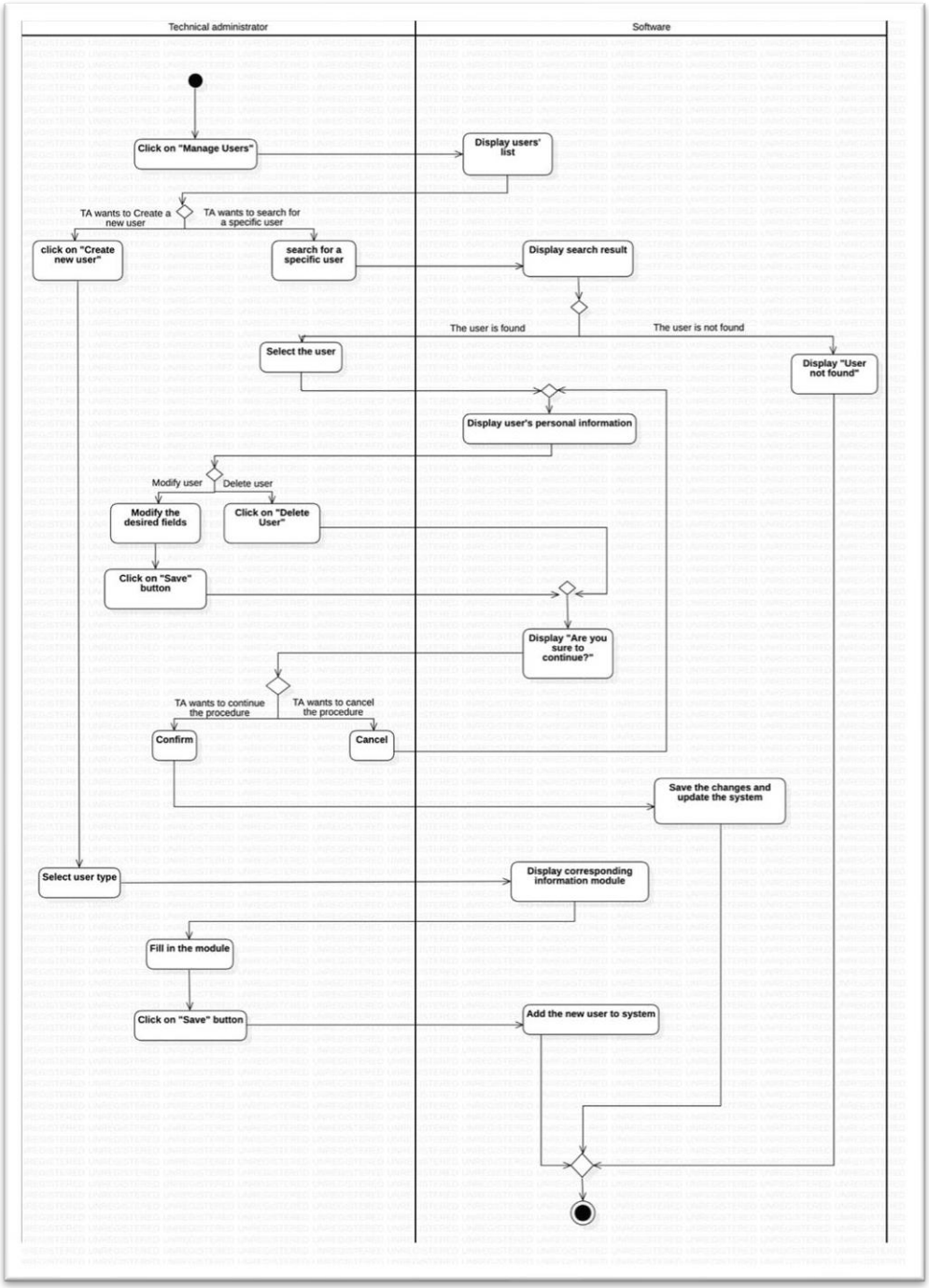


Figure 10: Manage Users Activity Diagram for Technical Administrator

File type of this diagram is available. To download, please click on the icon.

3.7 Backup Activity Diagram for Technical Administrator

In order to backup the system data, the technical administrator clicks on the “Backup” button and after that, the software displays the “Which file do you want to back up?” message. By this, the technical administrator has two options; to backup medical information or personal data. The software first provides an encrypted backup file and then displays the “Browse the location” message. Finally, the technical administrator specifies the location for the backup file to be stored and clicks on “Save” button and the activity finishes.

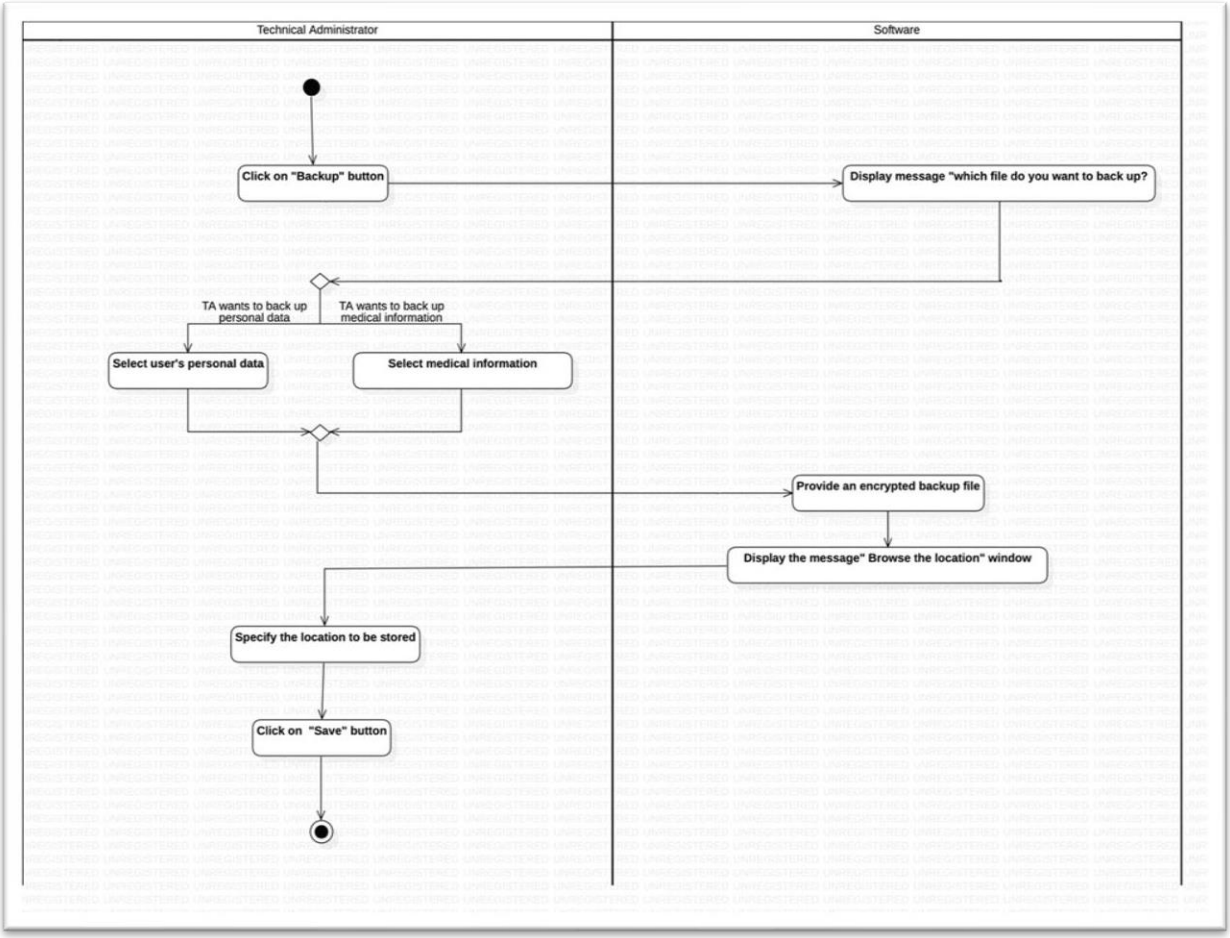


Figure 11: Backup Activity Diagram for Technical Administrator

File type of this diagram is available. To download, please click on the icon.

4. Class Diagram

In our class diagram, we have considered a class named “User” which indicates users of the system and is divided into “Clinical User” and “Technical User” with generalization relationship. Here, by “Clinical User” we mean patients and specialized practitioners and by “Technical User” we mean the technical administrator of the system. It is worth mentioning that “Patient” and “Specialized Practitioner” are two individual classes that are connected to the “Clinical User” class (parent) with a generalization relationship.

The ”User” class has methods such as: Login, logout and manage tickets and all these methods are inherited to “Clinical User” and “Technical User”.

According to the system requirements, the “Technical Administrator” class requires methods such as access to login, conduct backup, and manage software.

On the other side, the ”Clinical User” can visualize their profile and manage the “Software”. Since “Clinical User” is the parent class, its abovementioned methods are inherited by “Patient” and “Specialized Practitioner” classes.

If we want to go into more details, the “Specialized Practitioner” class can perform these methods: set appointment with patients, collect patients’ health data, prescribe for patients, visualize patients’ medical data, modify parameter thresholds, measure health parameters, observe questionnaires, and request examinations. On the other hand, methods like manage booked appointment, visualize health data, attend visit sessions, upload health parameters, fill questionnaires, and take examination belong to the “Patient” class.

When it comes to the “Software” class, it can perform these methods: notify users of the system, update (appointment status, ticket status and etc.), calculate questionnaires’ score, store questionnaires’ score, save backup, transfer ticket, compare parameter thresholds, save or display exam, save prescription, display questionnaire, and save health parameters.

The “Prescription” class is connected to “Exam” and “Drug Prescription” classes with a composition relationship. As mentioned before, the specialized practitioner can prescribe the patient an examination or a drug. Therefore, the existence of classes “Exam” and “Drug Prescription” are dependent to the “Prescription” class.

The “Health Parameters” class are two types; the first type is “In-Hospital Parameters” which are measured by the “Specialized Practitioner” and the second type is “At-Home Parameters” which are measured, uploaded, and inserted by “Patient”. Additionally, these parameters are compared to some “Parameter Thresholds”, being modified by the “Specialized Practitioner”.

The last thing to mention is that the “Software” class participates in most of the operations of the system but the most mentionable ones are saving “Backup”, transferring “Tickets”, and managing “Login”.

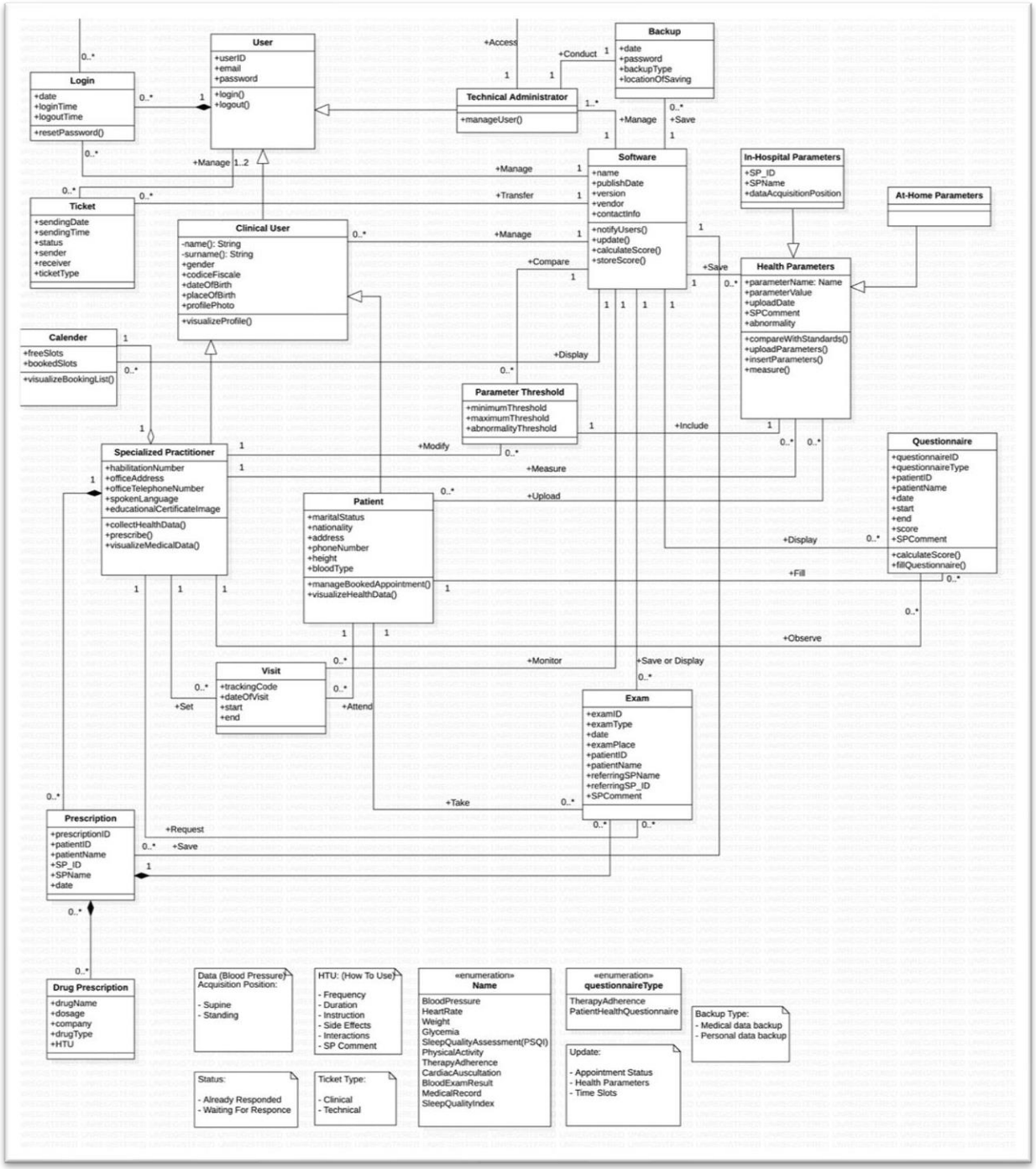


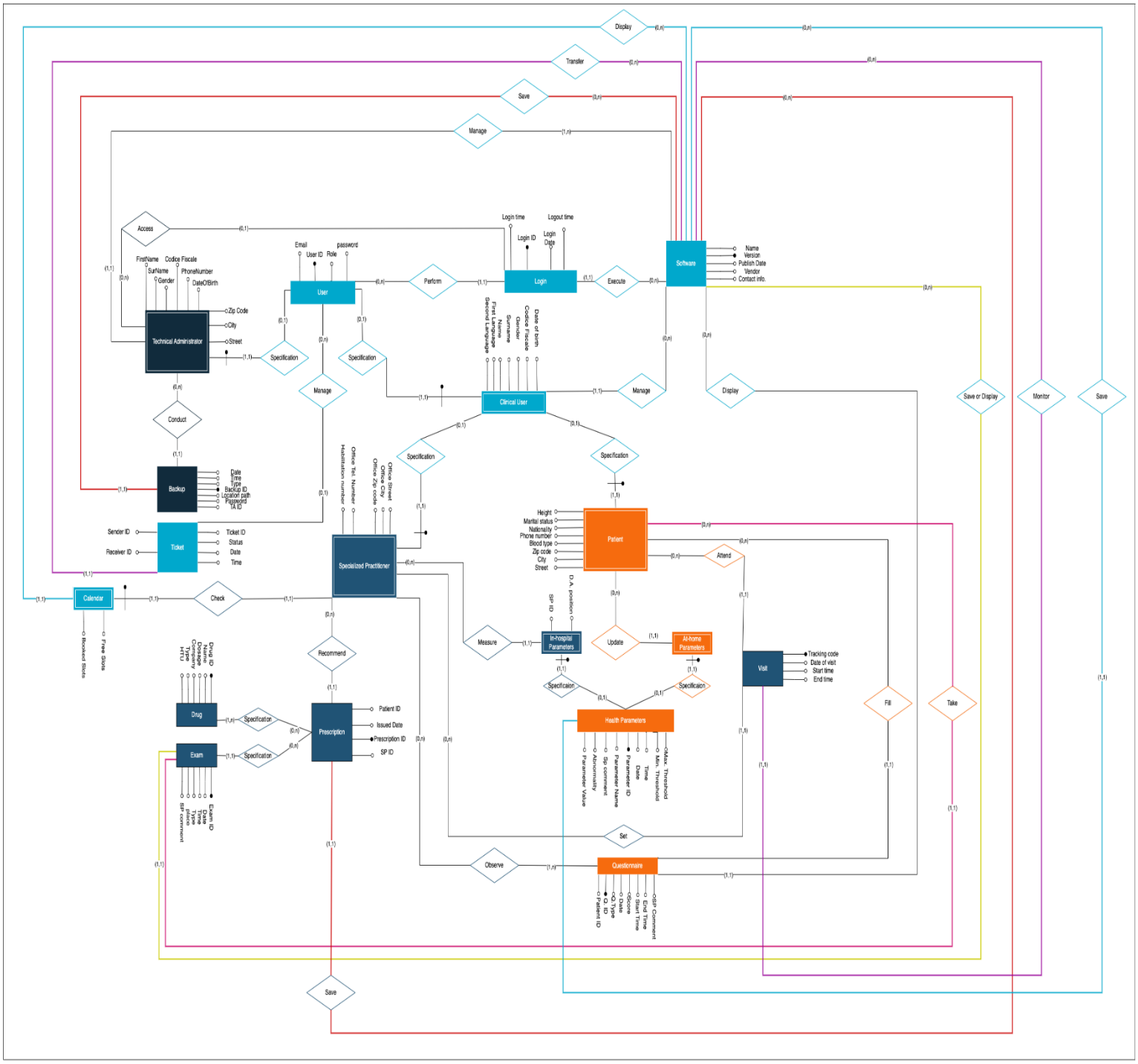
Figure 12: Class Diagram

File type of this diagram is available. To download, please click on the icon.

5. Modeling and description of database (ER-Diagram)

5.1 ER-Diagram

Figure 13: ER-Diagram



5.2 Relational Model

The entities of ER-Diagram are represented in below table with foreign keys in blue.

ENTITY	DESCRIPTION	ATTRIBUTES	KEY
User	A person that uses DB	Email, Password, user role	User ID
Clinical User	Consists of Patient and Clinical Administrator	First Name, Surname, Date of Birth, Codice Fiscale, Gender, First Language, Second Language	Clinical User ID
Technical Administrator	The user in charge of database management		TA ID
Patient	The user that undergoes treatment	Nationality, Phone Number, Blood Type, Marital Status, Height, City, Street, ZIP Code	Patient ID
Specialized Practitioner	A qualified user for prescribing medicine for patient treatment	Habilitation Number, Office Tel. No., Office City, Office Street, Office ZIP Code, Educational Certificate Image	SP ID
Visit	Face to face interaction between Patient and Clinical Administrator to Check Patient status and parameter as well as taking at-hospital Parameters	Visit Date, Start Time, End Time	Tracking Code
Login	Sequence of steps that user takes to get access to the system	Login Date, Login Time, Logout Time	Login ID
Software	Software used for at-home monitoring of the Patient	Name, published date, Vendor, Contact Info	Version
Prescription	A set of Medication orders or exams prescribed by Clinical Practitioner	Patient ID, Specialized Practitioner ID, Issued Date	Prescription ID
Drug	Medicines prescribed by Specialized Practitioner for treatment of the Patient	Name, Dosage, Company, Type, How to Use (HTU)	Drug ID
Exam	Medical Examination prescribed by Specialized Practitioner for evaluation of Patient health condition	Exam Date, Exam Time, Exam Type, Exam Place, SP Comment	Exam ID

Health Parameters	Set of measurements and indicators for assessment of the Patient health condition	Parameter Name, Date, Time, Minimum Threshold, Maximum Threshold, Abnormality Threshold, Abnormality, Parameter Value, Specialized Practitioner Comment	Parameter ID
In Hospital Parameters	Health parameters taken from the Patient in Hospital	Hospital Parameter ID, Specialized Practitioner ID, Data Acquisition Position	SP ID
At Home Parameters	Health parameters taken from the Patient at home		Parameter ID
Backup	Duplication of data to protect them against software corruption, data loss and any unexpected events	Technical Administer ID, Backup Date, Backup Time, Backup type, Backup Password, Location Path,	Backup ID
Calendar	A scheduling tool used by Special Practitioner to manage their appointments	Free Slots, Booked Slots	SP ID
Questionary	Consists of the "Therapy Adherence" and "Patient Health Questionary" to assess Patient's overall health status and their therapy adherence	Questionary Type, Questionary Date, Questionary start time, Questionary End time, Questionary Score, Specialized Practitioner Comment, Patient ID	Questionary ID
Ticket	Messaging method for communication among the users	Sender ID, Receiver ID, Status, Ticket Date, Ticket Time	Ticket ID

Table 2: Entities and attributes descriptions of ER-Diagram

the relationships contained in ER-Diagram are represented in following table;

RELATIONSHIP	Cardinalities	**COMPONENTS**
Specification	(0,1) (1,1)	[User, Clinical user], [Clinical User, Patient], [Clinical User, Specialized Practitioner], [User, Technical Administrator]
Perform	(0, N) (1,1)	User, Login
Execute	(1,1) (0, N)	Login, Software
Access	(0,1) (0, N)	Login, Technical Administrator
Manage	(1,1) (1, N)	Technical Administrator, Software
Manage	(0, N) (0,1)	User, Ticket
Manage	(1,1) (0, N)	Clinical User, Software
Conduct	(0, N) (1,1)	Technical Administrator, Backup
Save	(0, N) (1,1)	Software, Backup

Transfer	(0, N) (1,1)	Software, Ticket
Display	(0, N) (1,1)	Software, Calendar
Check	(1,1) (1,1)	Specialized Practitioner, Calendar
Display	(0, N) (1,1)	Software, Questionary
Observe	(0, N) (1, N)	Specialized Practitioner, Questionary
Save or Display	(0, N) (1,1)	Software, Exam
Monitor	(0, N) (1,1)	Software, Visit
Save	(0, N) (1,1)	Software, Prescription, Health Parameter
Recommend	(0, N) (1,1)	Specialized Practitioner, Prescription
Specification	(0, N) (1, N)	Prescription, Drug
Specification	(0, N) (1,1)	Prescription, Exam
Measure	(0, N) (1,1)	Specialized Practitioner, In Hospital Parameter
Specification	(1,1) (0,1)	[In-Hospital Parameter, Health Parameter] [At-Home Parameter, Health Parameter]
set	(0, N) (1,1)	Specialized Practitioner, Visit
Attend	(0, N) (1,1)	Patient, Visit
Fill	(0, N) (1,1)	Patient, Questionary
Take	(0, N) (1,1)	Patient, Exam
Update	(0, N) (1,1)	Patient, At-Home Parameter

Table 3: table of ER-diagram relationships and cardinalities

6. Description of the Graphical User Interface (GUI)

In This part, different graphical interfaces of the software for each user are explained. Additionally for better understanding of the process, instead of setting separate sections for tables and queries description, the important ones are brought in this part of report along its relevant interface.

6.1 Login

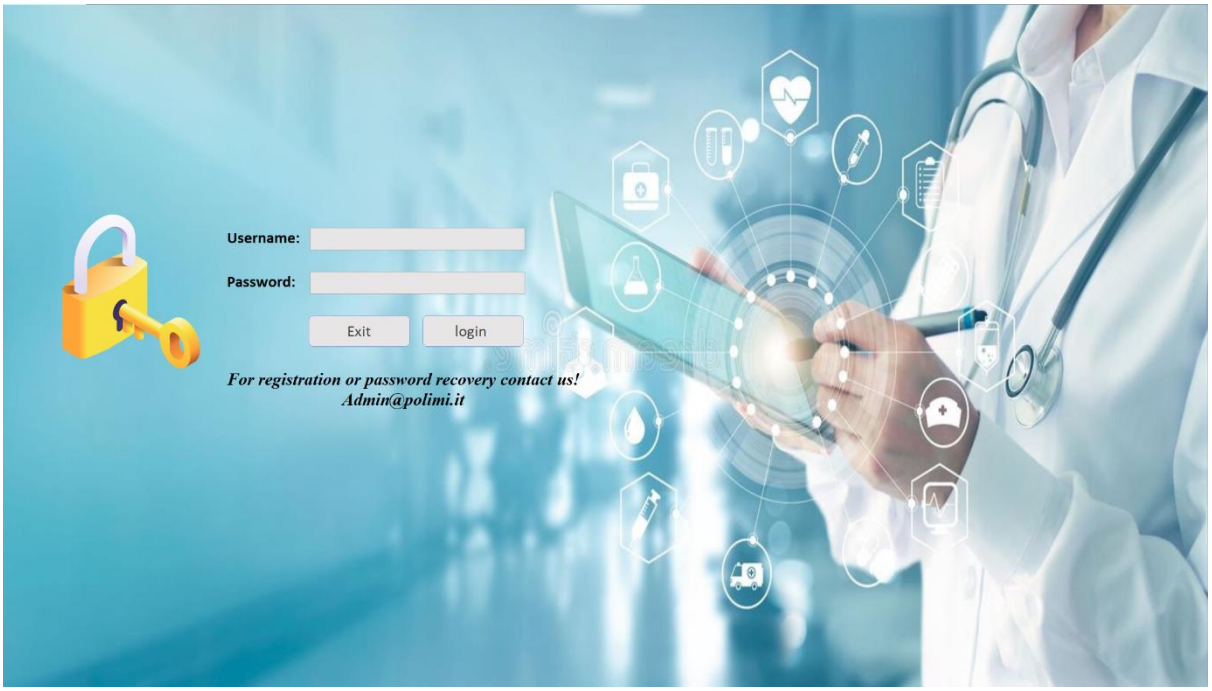
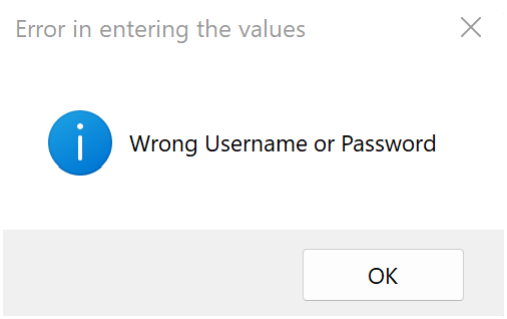
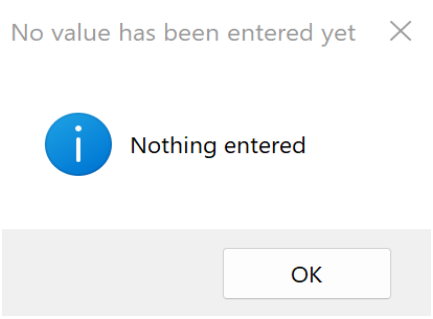


Figure 14: Login page

The picture above is the Login page of our system, which is used to authenticate and authorize users to access specific areas of the system based on their roles. After clicking on the Login button, if the username or password is incorrect or a field is leaved empty, an error message informs the user. Also, as a security point, the system will not tell the user which field entered wrong.





If the credentials are correct and matched with the “User_ID” and “Password” in the table “User”, users will direct to their specific profiles based on their roles.

There are three possible profile areas:

1. Patient Area
2. Special Practitioner Area
3. Technical Administrator Area

Each profile offers different features and functionalities tailored to the user's role. The Login page ensures that only authorized users can access the system and provides them with personalized access based on their roles.

Registration and Password recovery:

We found it straightforward to create a form in MS Access for patient registration. Users could either sign up directly or request confirmation from the technical administrator. However, we encountered uncertainty regarding the responsibility for this task and whether users needed to register themselves or if they were already registered. To address this, we decided to include an email option at the bottom of the login page for registration.

In order to recover their passwords, users are instructed to contact the Technical Administrator via email. By reaching out to the Technical Administrator, users can initiate the password recovery process and receive the necessary assistance to regain access to their accounts.

Recording the Access data:

The system will keep a log of all system accesses by saving the users' Username, Login time, Login date, and assigning a unique "Log_ID" to each access. This information will be stored in a table named "LogT" within our database.

LogT

LogID	TimeStamp	UserName	Activity
{03CA2A44-3CD5-45E3-A8D3-236611E2285A}	5/25/2023 3:33:30 PM	6	Logon
{042B383B-BB07-4B6F-BA1F-04C99C4030F9}	5/29/2023 10:19:58 AM	6	Logon
{04A65A96-ACC5-4093-933B-934218660122}	5/29/2023 12:43:15 PM	12	Logon
{058E343C-84E7-4082-8755-A03423E0C8C6}	5/25/2023 1:55:31 PM	9	Logon
{0B15C244-56F8-4853-ACF3-8EED5E6A6748}	5/25/2023 10:25:01 AM	5	Logon
{0C4E9549-7735-4151-B6BE-32D0868BDE8E}	5/29/2023 11:15:07 AM	6	Logon
{0EB7E400-0EC2-42A0-A51E-C130CEB96116}	5/24/2023 6:12:11 PM	5	Logon
{0FE9AF4A-1158-4E06-A7A5-95A665398CEF}	5/28/2023 5:04:06 PM	9	Logon
{1201995D-9215-49C8-A0C2-FF80F6E5507B}	5/29/2023 4:34:15 PM	6	Logon
{18F62700-7915-4486-8498-C84074CC6C2B}	5/28/2023 8:02:35 PM	5	Logon
{1943C47C-EFA8-4F48-B060-55DB334AD4B6}	5/24/2023 5:02:04 PM	6	Logon
{19A9D102-8A46-4295-99C0-8C06A01EFEA8}	5/25/2023 12:33:39 PM	5	Logon
{2002F8DB-35EE-4F54-85B3-D81EA46E3897}	5/29/2023 9:58:11 AM	6	Logon
{2078CB5D-595C-40A4-9FDA-4C9FBE093113}	5/25/2023 11:59:12 AM	5	Logon
{2457EA9E-81FA-4ECF-B171-4884E06C7F2F}	5/28/2023 5:02:17 PM	5	Logon
{2636D00C-AFA5-40BD-9112-C194007072FD}	5/25/2023 1:39:08 PM	9	Logon
{264CE88D-0178-4482-B5B8-F93CD94A3813}	5/28/2023 10:41:33 AM	5	Logon
{2A8D3100-B204-4EB5-B808-4CDD5B5E2439}	5/29/2023 11:33:49 AM	5	Logon
{2B1174F8-3A53-4464-BBB2-4AEFF8823476}	5/29/2023 10:42:07 AM	6	Logon
{2C35A715-13A0-4F1C-AEC5-9ED6C61AEF3B}	5/29/2023 10:30:08 AM	6	Logon
{2CFD53BE-244C-4772-A898-CB9B3EAD5408}	5/24/2023 6:20:34 PM	5	Logon
{2D70E656-2D04-454C-AF9E-E0A9D6F4843E}	5/29/2023 10:20:05 AM	9	Logon
{2DDE6453-39BB-4771-823D-AE914300E198}	5/29/2023 6:07:09 PM	5	Logon
{2E19EF57-6115-430C-94DE-08665947606A}	5/29/2023 12:26:43 PM	5	Logon
{2EA50CF5-2938-4CBE-B6CF-E48F79932B14}	5/29/2023 10:37:49 AM	6	Logon
{2FA256C9-BA99-4CC6-B82E-88400A72D58A}	5/25/2023 1:55:09 PM	5	Logon
{32512981-B94C-4549-BD83-EBAD5534B18C}	5/25/2023 10:17:40 AM	5	Logon
{328919E0-C268-4192-9442-6EF3E786129D}	5/25/2023 1:29:43 PM	5	Logon
{3457B9D5-45DF-4E3E-B55F-9502C07E4882}	5/25/2023 3:21:17 PM	9	Logon
{34978D20-841A-42A5-BA83-2B60C418DACD}	5/28/2023 6:30:07 PM	9	Logon
{376B0DEF-51FE-4495-973D-57F0A080C0A3}	5/30/2023 5:45:51 PM	6	Logon
{38691EF3-0BD8-4799-A615-0D488191DB46}	5/28/2023 8:23:09 PM	6	Logon
{3BE13F7A-F9A7-468F-93D2-7B3FEF34ABD3}	5/29/2023 10:01:09 AM	9	Logon
{3C894E44-BC71-4531-AD5A-C48D20049DA0}	5/25/2023 1:36:01 PM	6	Logon

Figure 15: LogT table of access

Login page implementation:

In order to creating the login page in MS Access, we utilized a form and incorporated two buttons. The first button is responsible for sending a request to the software, which verifies the entered username and password, subsequently allowing the user to log in. The second button is designed to exit the software. The exit button operates as a macro, closing the current window and the associated database. The login process is facilitated by Visual Basic code, which is configured to execute when the "Login" button is pressed.

```
    If IsNull(Form_P_login.u_txt) Then
        MsgBox "Nothing entered", vbInformation, "No value has been entered yet"
    ElseIf IsNull(Form_P_login.p_txt) Then
        MsgBox "Nothing entered", vbInformation, "No value has been entered yet"
        ElseIf (DLookup("User_ID", "User", "CStr(User_ID)='" & Form_P_login.u_txt.Value & "' and Password='" & Form_P_login.p_txt.Value & "'")) Then
        Role = DLookup("Role", "User", "CStr(User_ID)='" & Form_P_login.u_txt.Value & "'")


        ' Open forms based on Role
        Select Case Role
            Case "Patient"
                MsgBox "Welcome to the Patient Area!", vbInformation, "Let's rock"
                DoCmd.OpenForm "P_MNG_Area"
            Case "Specialized Practitionor"
                MsgBox "Welcome to the Specialized Practitioner Area!", vbInformation, "Let's rock"
                DoCmd.OpenForm "SP_MNG_Area"
            Case Else
                MsgBox "Welcome to Technical Administrator Area!", vbInformation, "Let's rock"
                DoCmd.OpenForm "TA_MNG_Area"
        End Select

        DoCmd.Close acForm, "P_login", acSaveYes
        TempVars("Username").Value = Form_P_login.u_txt.Value
        Globals.logging "Logon"



    Else
        MsgBox "Wrong Username or Password", vbInformation, "Error in entering the values"
        Exit Sub
    End If

    ' Update the login_data table with Role
    rs = Form_P_login.u_txt.Value
    CurrentDb.Execute "UPDATE login_data SET ID = '" & rs & "', Role = '" & Role & "';"
End Sub
```

Figure 16: Visual basic code of Login

6.2 User Home page

The images below, illustrate a user interface for Patient, Specialized Practitioner, and Technical Administrator with a welcoming quote. A side menu has been implemented on the left side of every page to provide users with convenient access to main pages and tasks. The menu has been tailored for each user type, taking into account their specific tasks and responsibilities. This feature enables users to quickly navigate to desired pages. Additionally, each user area has been designed with a distinct colour scheme, creating a visually distinguishable and personalized experience for users.

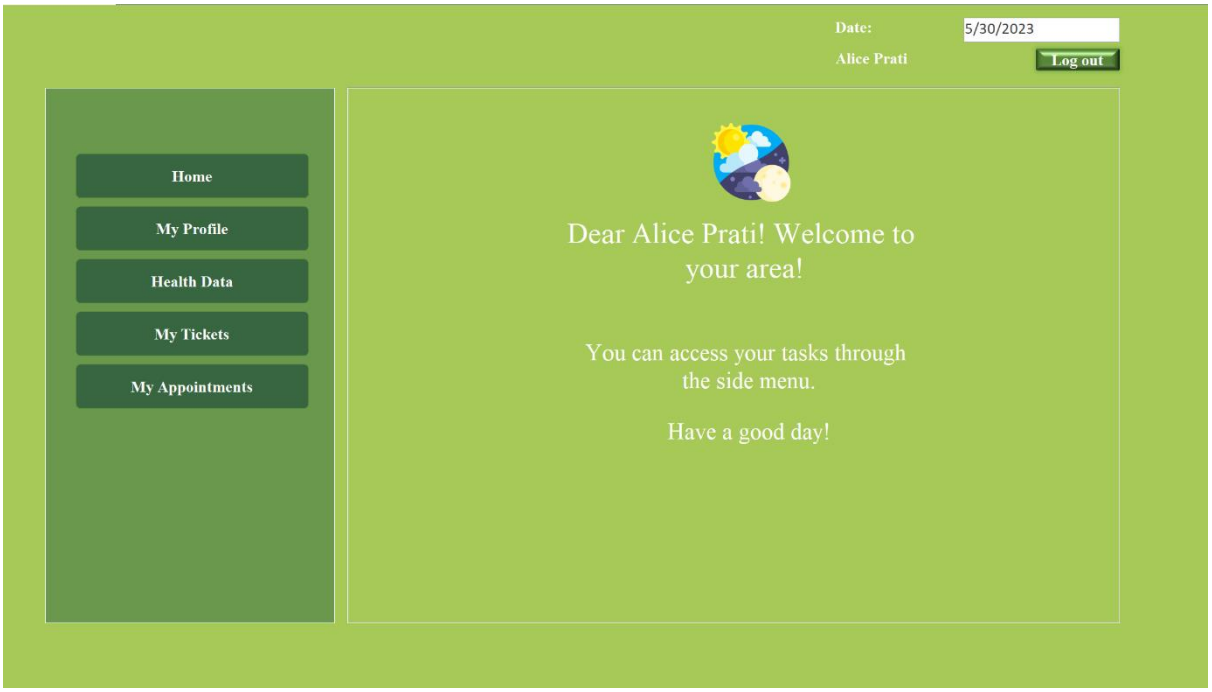


Figure 17: Patient's Home Page

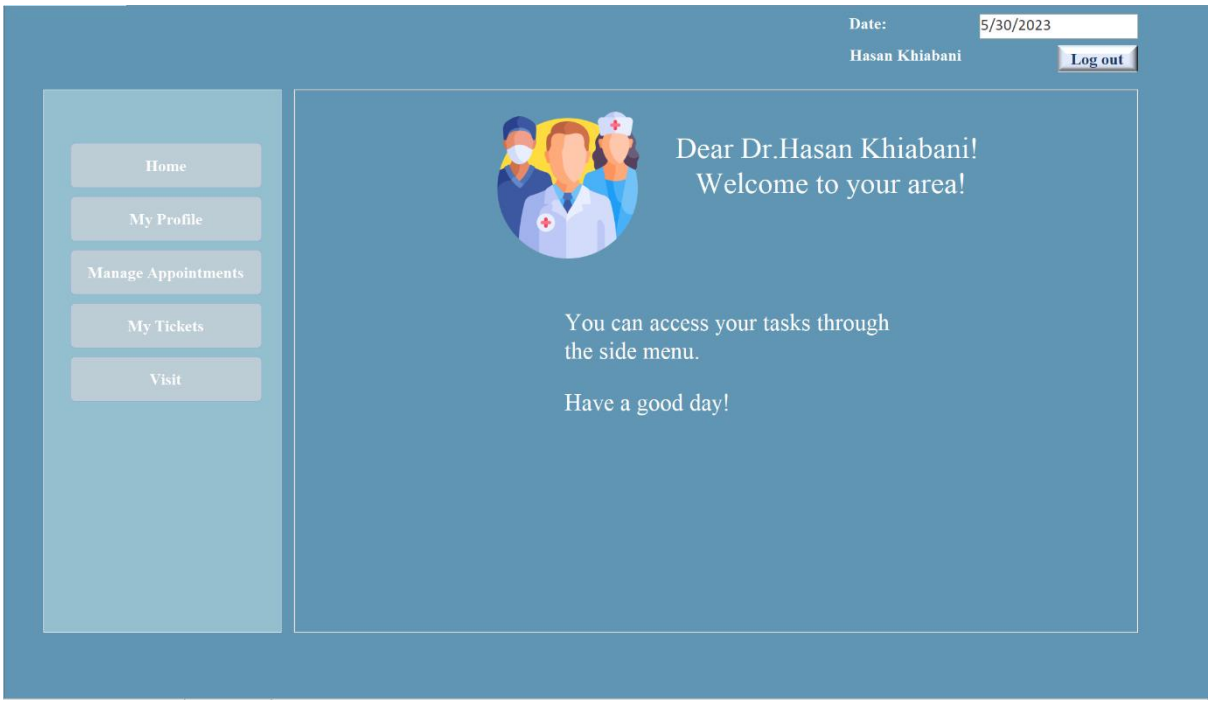


Figure 18: Special Practitioner's Home Page

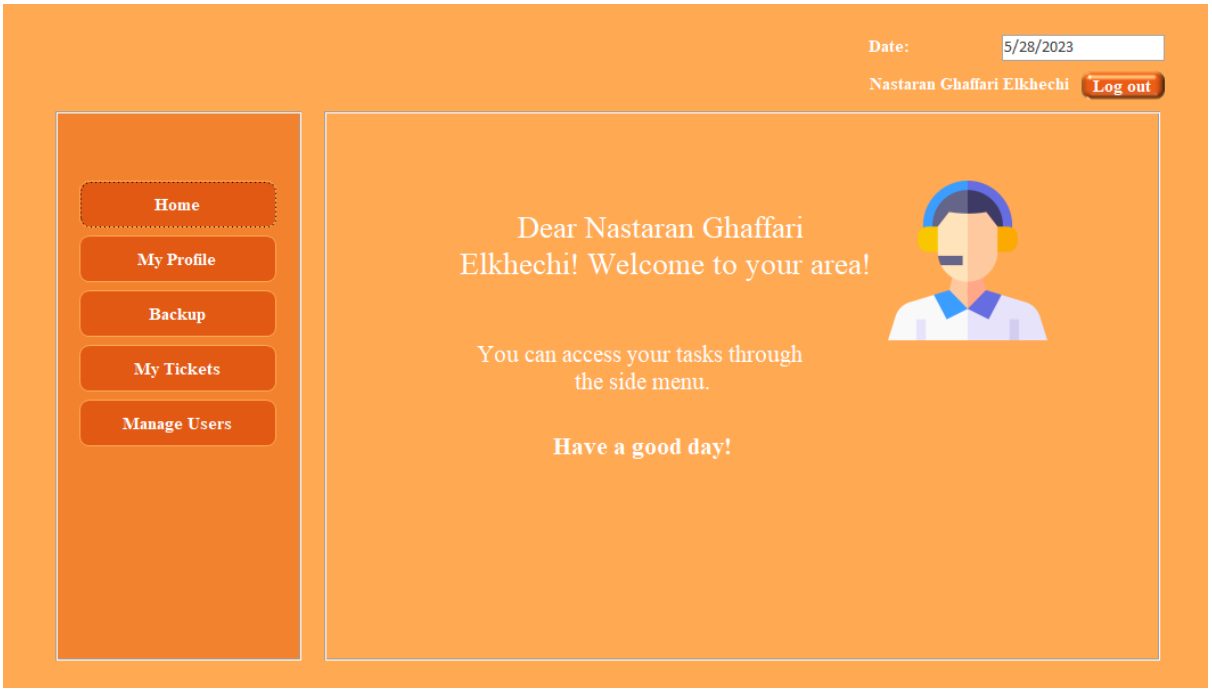


Figure 19: Technical Administrator's Home Page

6.3 Patient's Interface

6.3.1 Patient's Profile

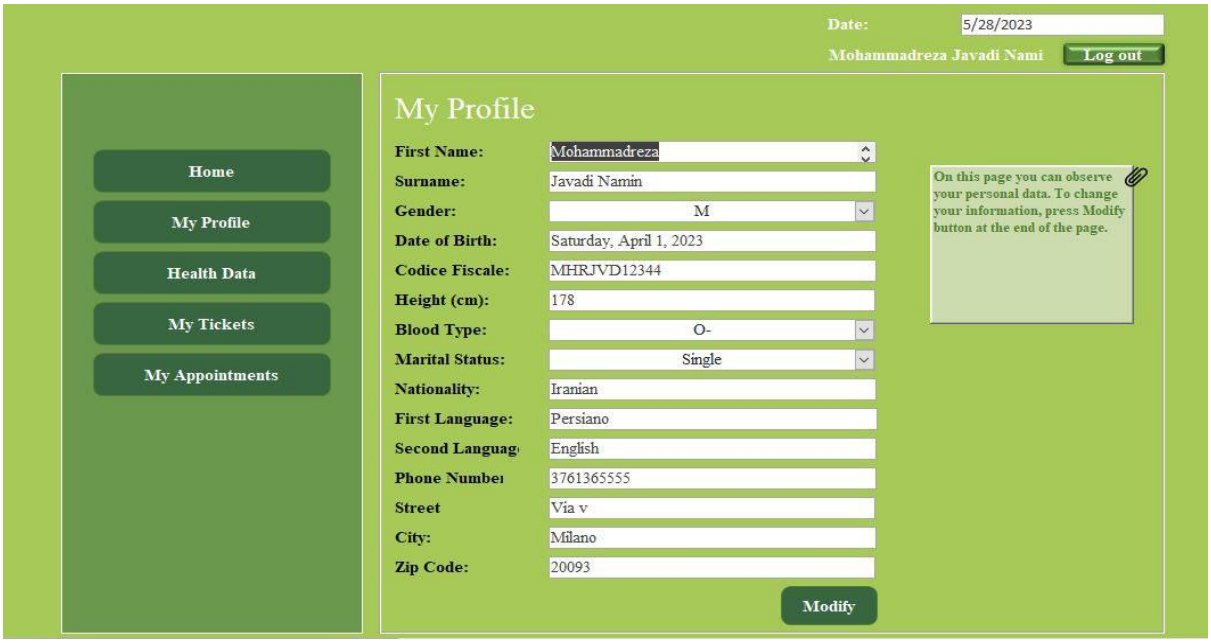


Figure 20: Patient's My Profile section

One of the features provided by the software to patients is the ability to access and modify their personal data. This functionality can be achieved by clicking on the "My Profile" button, which directs the patient to a page containing their personal data. This data is exclusively designed for the patient and includes essential details such as their full name, gender, date of birth, fiscal code, height, blood type, marital status, nationality, primary and secondary languages, phone number, and address (including street, city, and zip code).

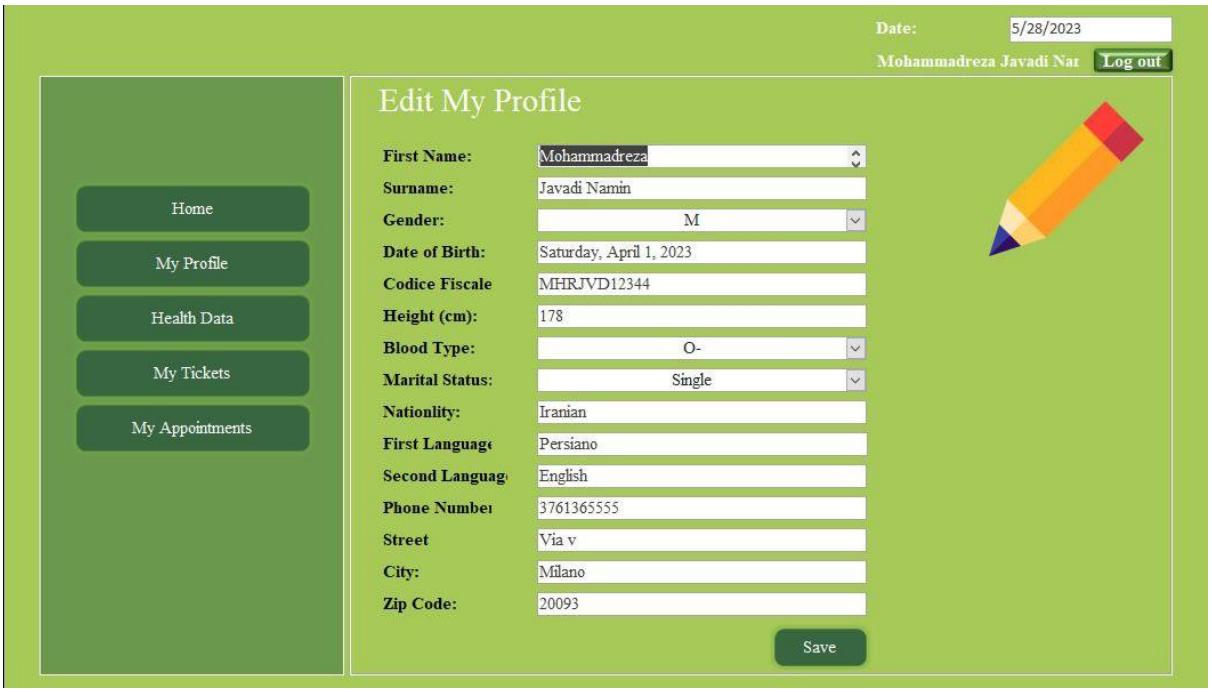


Figure 21: Patient's profile edition area

Additionally, patients are able to modify their personal data by selecting the "modify" button. It directs them to a specific page where they can modify their data. At the end, by clicking on "Save" button, new data is recorded to the software.

6.3.2 Patient's health data section

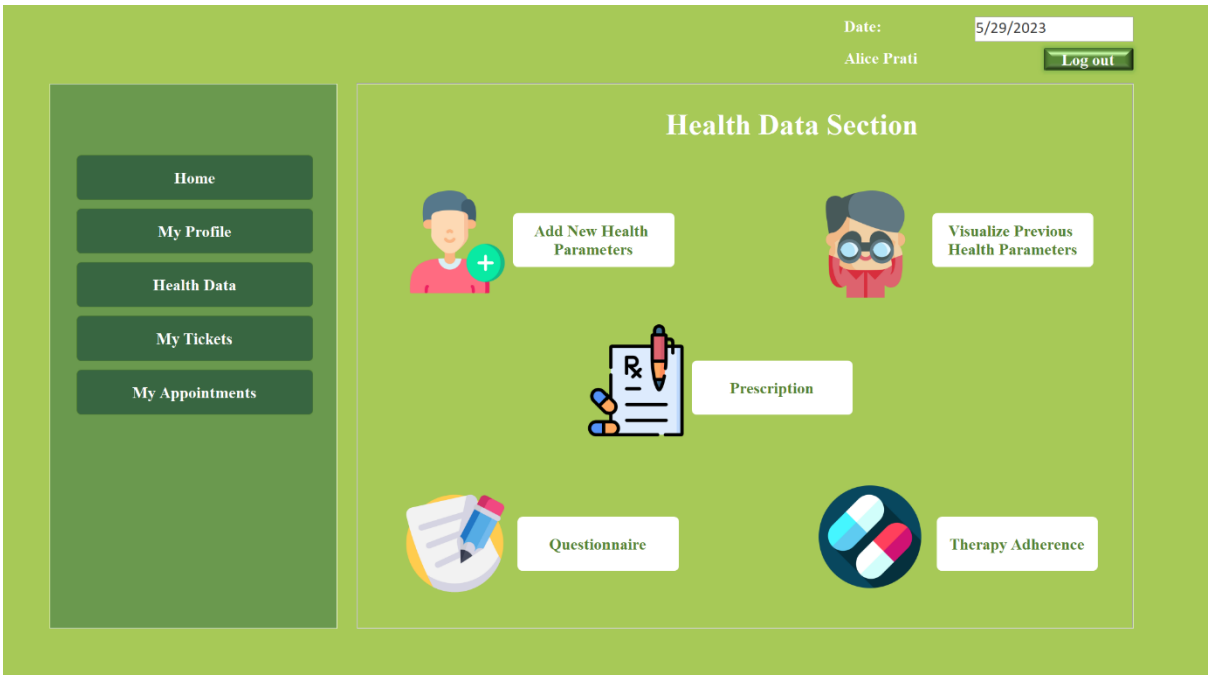


Figure 22: Patient's Health Data area

The picture above is the "Health Data" page of a patient's profile. This page is designed to help the patient manage and track their health parameters or measurements, their questionnaire, therapy adherence and give an access to their prescriptions.

1. **Insert new health parameters (At-home):**

On this page, there is an "Add New Health Parameters" button. By clicking on this button, the patient can enter a new series of measured health data.

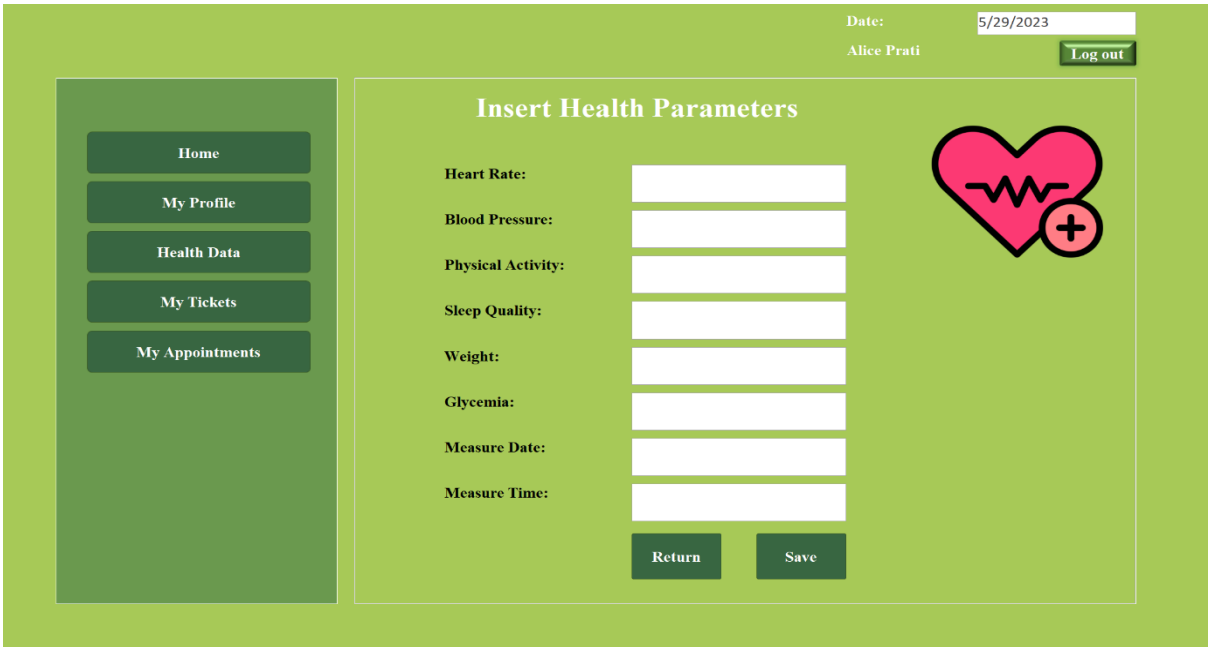


Figure 23: Patient's area for entering Health Parameters

Clicking on the button opens a form where the patient can input the relevant information related to their health measurements.

The purpose of the "Add New Health Parameters" button is to provide a convenient way for patients to record their health data within their profile. It allows them to regularly update their health information, such as blood pressure, weight, heart rate, or any other relevant parameters. By utilizing this button and entering their measured health data in the relevant fields, patients can keep a record of their health progress over time. This can be valuable for both the patients themselves and their healthcare providers, as it enables better monitoring, analysis, and decision-making regarding the patient's health.

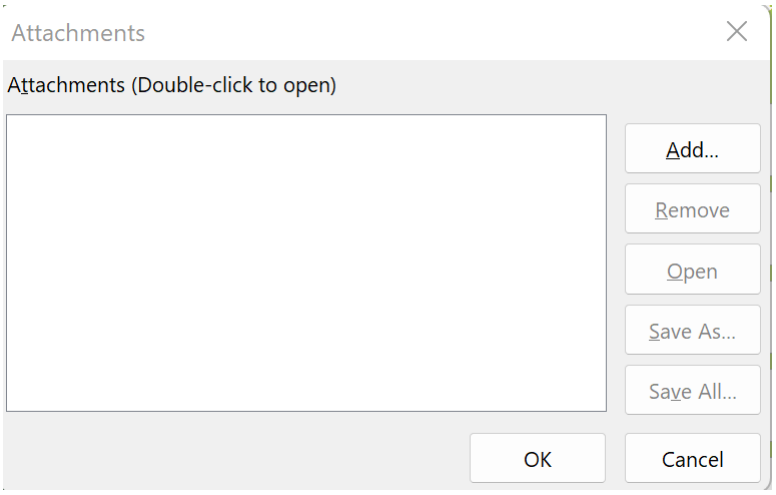


Figure 24: Area for uploading Health parameter files of patient

It should be noted that the patient can browse their system and upload the records file of their parameters which collected from their medical devices in the related fields by clicking on the blank field in front of the name the parameters (figure 24). Moreover, there is no format limitation for uploading health information.

Insert new Parameters (At-home) implementation:

In this page we have use a form and some Macro buttons in order to save new data or return to the previous page. These data will be stored in “At_home_parameters” table. In first steps we decided to use append query in order to add new data to the table, but it does not work with the multivalued file type (Attachments). So, we decided to use Macro button instead.

At_home_parameters

ID	Patient_ID					weight	Glycemia	Measure_Date	Measure_Time
89	13	(0)	(0)	(0)	(0)	62	230	12/2/2023	11:13
90	13	(0)	(0)	(0)	(0)	60	130	12/3/2023	20:26
91	14	(1)	(1)	(1)	(1)	66	120	12/11/2022	6:26
92	12	(1)	(1)	(1)	(1)	55	190	5/20/2023	17:25
93	12	(1)	(1)	(1)	(1)	60	120	10/5/2023	10:11
95	5	(1)	(1)	(1)	(1)	89	120	5/18/2023	10:26
(New)	0	(0)	(0)	(0)	(0)				

Figure 25: Patient’s At-home parameters table in access

6.3.3 Visualize Previous health parameters

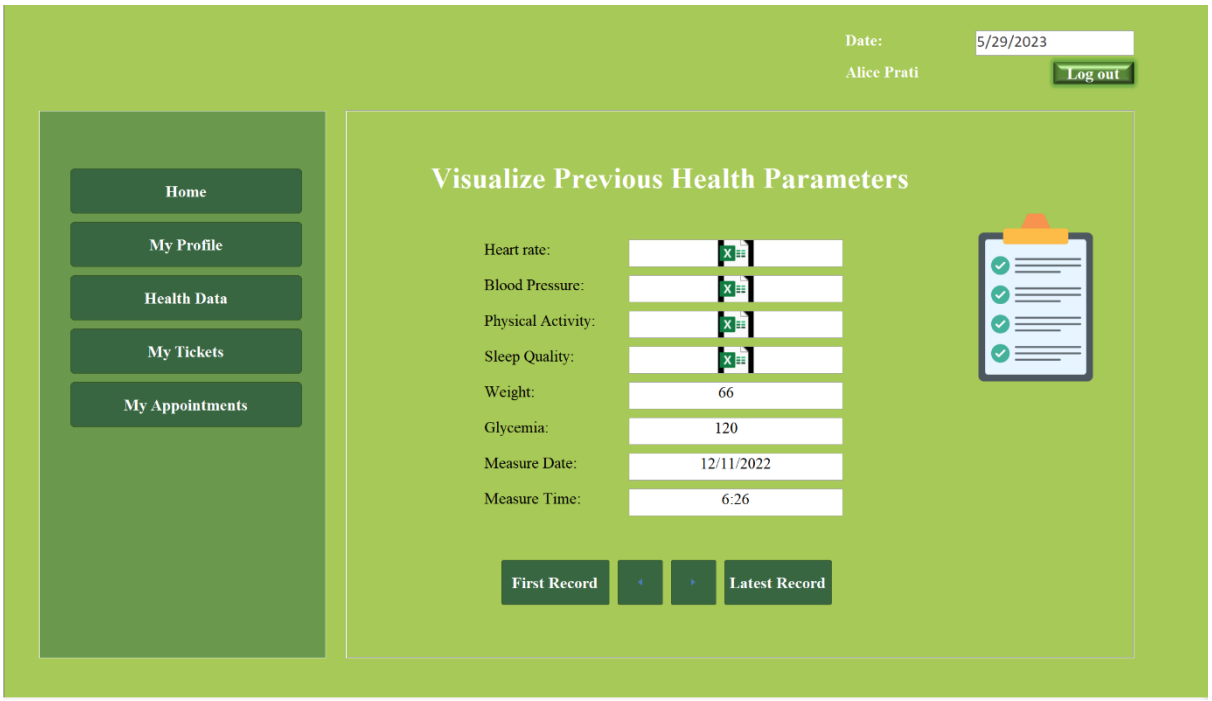


Figure 26: Patient's Health Parameters visualization area

In addition, the "Health Data" page of the patient's profile also includes a "Visualize Previous Health Parameters" button. By clicking on this button, the patient is directed to a new page specifically designed for navigating through their previous records of health parameters (Fig 26).

On this page, the patient can explore their historical health data and review their past measurements. To facilitate navigation, interactive buttons are provided, including "First Record," "Previous Record," "Next Record," and "Latest Record."

These navigation buttons allow the patient to move between different records of their health parameters. By clicking on the "First Record" button, the patient can jump to the earliest recorded health data. The "Previous Record" button allows them to move back to the previous measurement, while the "Next Record" button takes them to the subsequent measurement. Finally, the "Last Record" button directs them to the most recent health parameter record.

This interactive navigation feature allows the patient to easily explore and analyse their health data in chronological order. It provides a convenient way to track their progress, identify patterns or trends, and make comparisons between different measurements over time.

Visualize Previous Health Parameters implementation:

For this part we have been stored the “User_ID” of the patient from the login page and then using it in an inner query of the “At_home_params_vis” form. This query shows just the results where Patient’s ID matches with login ID.

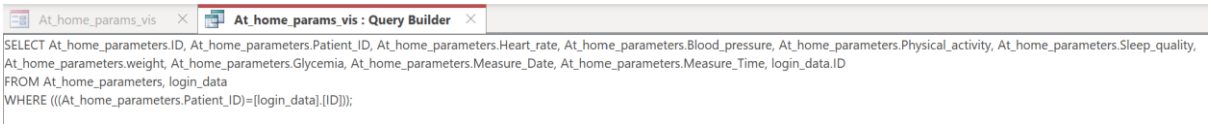


Figure 27: At-home params query code

2. Visualizing Prescriptions

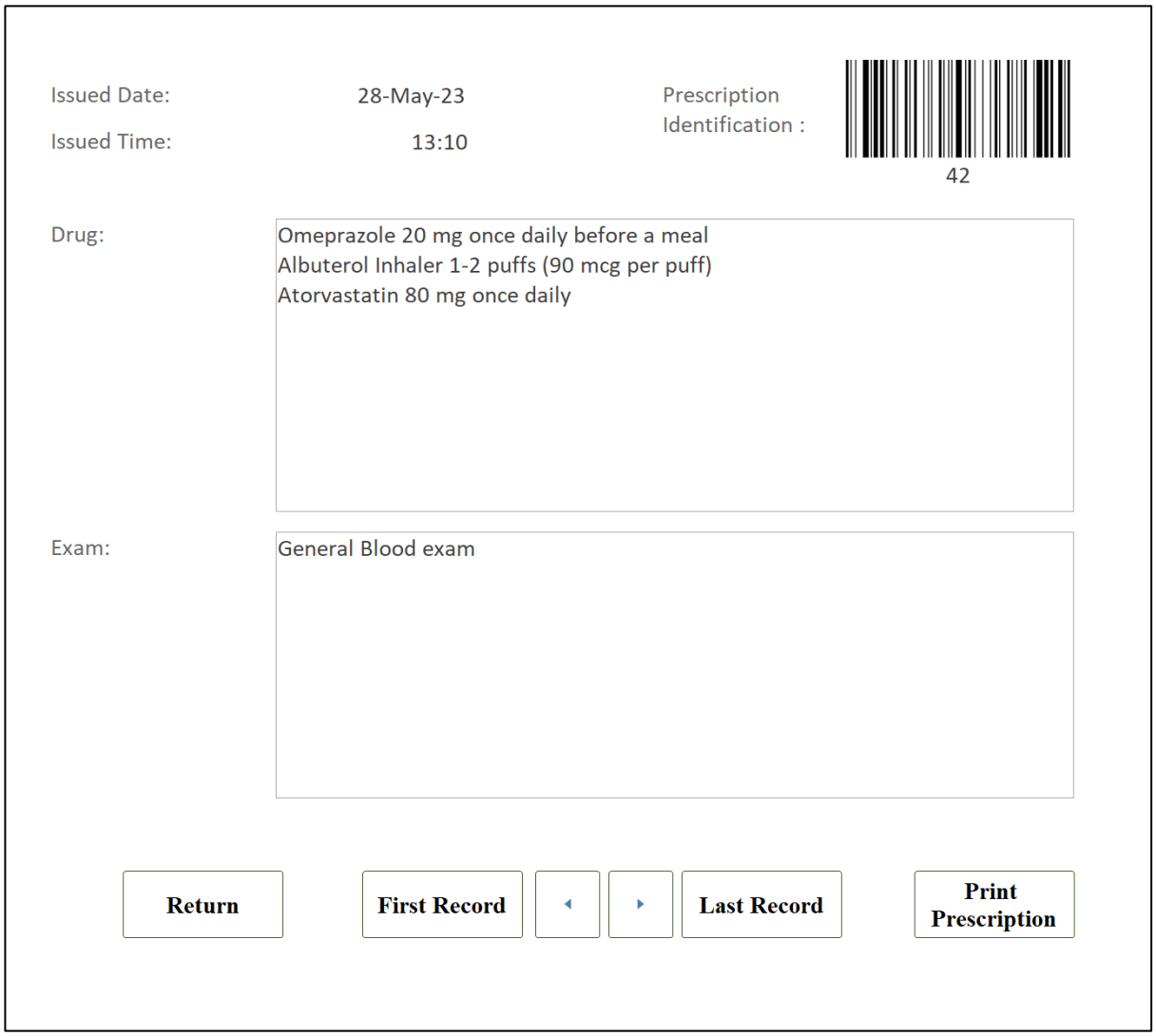


Figure 28: Patient’s Prescription visualization area

The "Health Data" page of the patient's profile also includes a "Prescription" button. Clicking on this button redirects the patient to a new page specifically dedicated to visualizing the prescriptions that their healthcare practitioner has prescribed.

On this page, the patient can view a visual representation of their prescriptions. The detail of each prescription includes information such as the prescribed medication, dosage instructions, duration, Exams required, and any additional notes provided by the healthcare practitioner.

The purpose of the "Prescription" button is to provide patients with easy access to their prescribed medications and treatment plans. By having a dedicated page for prescriptions, patients can quickly refer to their prescribed medications whenever needed, ensuring they have accurate information regarding their treatment regimen.

Having this functionality within the patient's profile offers convenience and centralization. It allows patients to have a comprehensive overview of their health data and prescriptions in one place, simplifying the management of their healthcare information.

In addition to the interactive navigation buttons which explained before, there is also a "Print Prescription" button available. This button allows the patient to generate a physical or digital copy of their prescription for their convenience.

By clicking on the "Print Prescription" button, the patient can initiate the process of generating a printable version of their prescription. This feature can be especially useful when the patient needs to provide a copy of their prescription to a pharmacy, healthcare provider, or for personal record-keeping purposes.

Visualizing prescriptions implementation:

All the prescription that Specialized practitioner prescribed before for the patients were stored in our database and the table “Prescriptions”. As a matter of fact, each prescription has an attribute of Patient ID. So, we have used a query to call all the prescriptions related to the patient which has logged in.

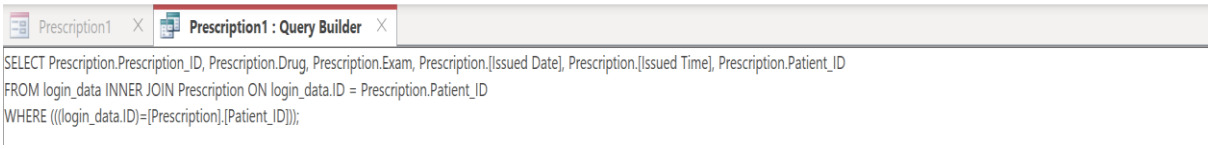


Figure 29: Prescription1 code

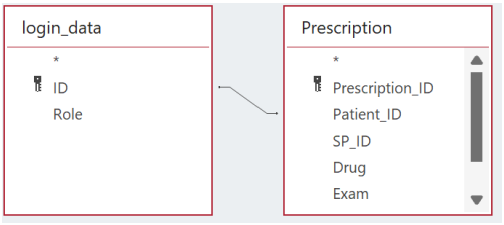


Figure 30: Relationships of Login_data and Prescrption tables

3. Filling questionnaire (PHQ9):

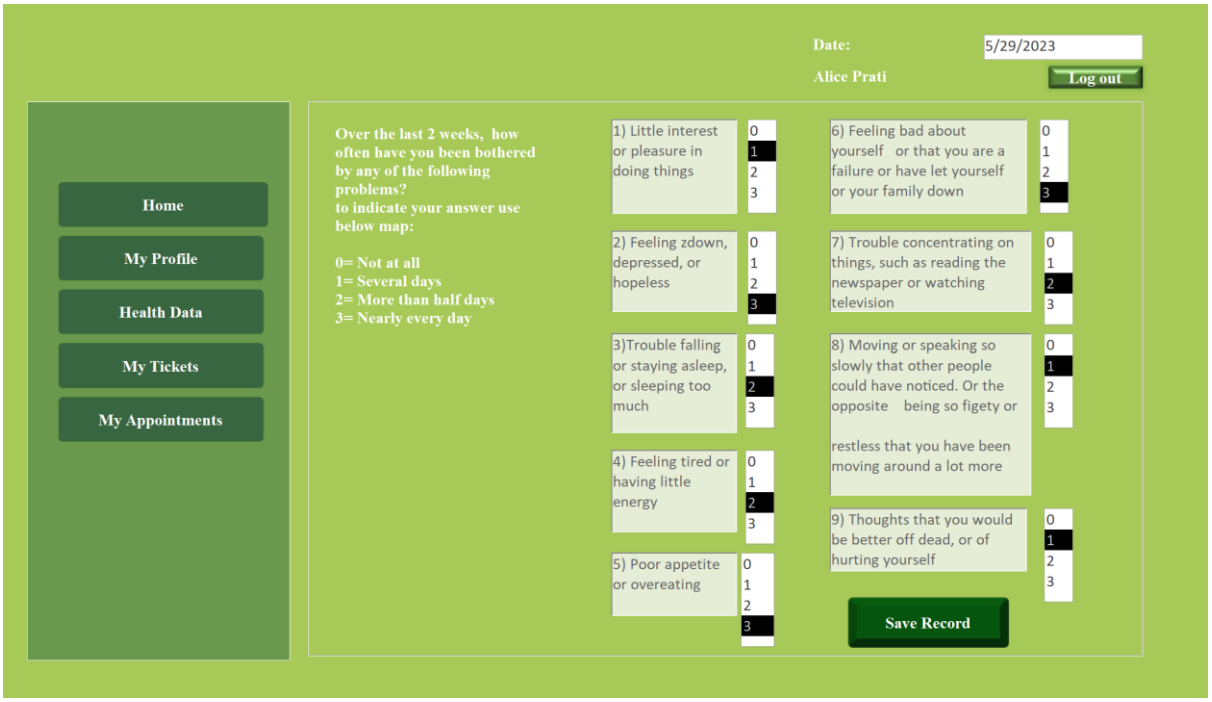


Figure 31: PHQ9 questionnaire area

On the "Health Data" page of the patient's profile, there is also "Questionnaire" button. Clicking on this button redirects the patient to a new page where they can complete a questionnaire consisting of scoreable questions related to their condition at that moment (Fig 40).

The questionnaire page presents a set of questions that the patient needs to answer by providing a score or rating based on their current condition. It's important to note that all questions are obligatory, meaning the patient must answer each question before proceeding. This ensures that a complete assessment is obtained.

Once the patient has provided scores for all the questions, they can click on the "Save" button. Upon clicking this button, a message is displayed confirming the successful saving of the questionnaire records. Additionally, the message also includes the overall score of the patient for that specific questionnaire, which provides a summary measure of their condition based on the scores given.

The inclusion of a questionnaire in the patient's profile serves various purposes. It allows healthcare providers to gather important data about the patient's current condition, track progress over time, and monitor treatment effectiveness. It also provides a standardized approach to assessing the patient's health status and can aid in identifying trends or changes in their condition.

Filling questionnaire (PHQ9) implementation:

In this form and during implementing PHQ9 questionnaire, we have used series of VBA code behind the form on the form-load and buttons.

```
Private Sub SaveRecord_Click()

    Dim db As DAO.Database
    Dim rs As DAO.Recordset
    Dim LoginID As Integer
    Dim fullName As String
    Dim Message As String
    Dim latestRecordID As Integer

    Set db = CurrentDb
    Set rs = db.OpenRecordset("Questionnaire", dbOpenTable)
    LoginID = DLookup("ID", "login_data")
    If IsNull(Me.Q1.Value) Or IsNull(Me.Q2.Value) Or IsNull(Me.Q3.Value) Or IsNull(Me.Q4.Value) Or IsNull(Me.Q5.Value) Or IsNull(Me.Q6.Value) Or IsNull(Me.Q7.Value)
    MsgBox "Please select a value for all questions before saving.", vbInformation, "Incomplete Form"
    rs.Close
    db.Close
    Set rs = Nothing
    Set db = Nothing
    Exit Sub
    End If
    ' Update the field in the table based on the checkbox value
    rs.AddNew
    rs("Q1") = Me.Q1.Value
    rs("Q2") = Me.Q2.Value
    rs("Q3") = Me.Q3.Value
    rs("Q4") = Me.Q4.Value
    rs("Q5") = Me.Q5.Value
    rs("Q6") = Me.Q6.Value
    rs("Q7") = Me.Q7.Value
    rs("Q8") = Me.Q8.Value
    rs("Q9") = Me.Q9.Value
    rs("Patient_ID") = LoginID

    rs.Update
    fullName = DLookup("Firstname & ' ' & Surname", "User", "User_ID=" & LoginID)
    latestRecordID = DMax("IDQuestionnaire", "Questionnaire", "Patient_ID=" & LoginID)
    Me.PHQScore.Value = DLookup("Score", "Questionnaire", "IDQuestionnaire=" & latestRecordID)
    Message = "Dear " & fullName & "! Thanks for filling the patient health questionnaire!your score is " & Me.PHQScore.Value
    MsgBox Message
    Close
    rs.Close
    db.Close
    Set rs = Nothing
    Set db = Nothing
    DoCmd.Close acForm, Me.Name
    DoCmd.OpenForm "My_health_data"
End Sub
```

```
Private Sub Form_Load()
    Dim LoginID As Integer
    LoginID = DLookup("ID", "login_data")
    Me.Patient_ID = LoginID
    fullName = DLookup("Firstname & ' ' & Surname", "User", "User_ID=" & LoginID)
    Me.loginName = fullName
End Sub
```

Figure 32: VBA code of PHQ9 questionnaire

All of the questionnaires will save in a table on our database which called “Questionnaire” with their time stamps.

P_MNG_PHQ9 | Questionnaire

IDQuestionnai	Patient_ID	QNTime	QNDate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Score
4	5	12:14:34 PM	5/22/2023	3	3	3	3	3	3	3	3	3	27
5	5	12:15:09 PM	5/22/2023	1	2	0	3	1	1	3	2	2	15
9	5	12:39:13 PM	5/22/2023	1	1	1	1	1	1	1	1	1	9
10	5	12:45:09 PM	5/22/2023	3	3	3	3	3	3	3	3	3	27
11	12	12:56:24 PM	5/22/2023	1	2	3	3	3	2	1	0	2	17
12	12	1:14:35 PM	5/22/2023	1	2	2	2	2	2	2	2	0	15
14	12	1:15:46 PM	5/22/2023	1	1	0	1	2	3	1	3	2	14
15	5	6:41:25 PM	5/24/2023	2	0	3	2	1	1	3	2	1	15
16	5	11:23:09 AM	5/25/2023	1	2	2	1	2	1	1	1	1	12
17	5	12:11:03 PM	5/25/2023	3	2	1	2	1	2	1	3	1	16
18	5	12:29:52 PM	5/25/2023	1	2	2	3	0	0	2	2	3	15
19	5	12:39:34 PM	5/25/2023	1	1	3	2	2	0	2	0	1	12
20	5	1:31:33 PM	5/25/2023	0	1	3	1	2	3	2	2	3	17
21	12	2:56:41 PM	5/29/2023	1	3	2	2	3	3	2	1	1	18

Figure 33: PHQ9 Questionnaire table in access

4. Therapy adherence:

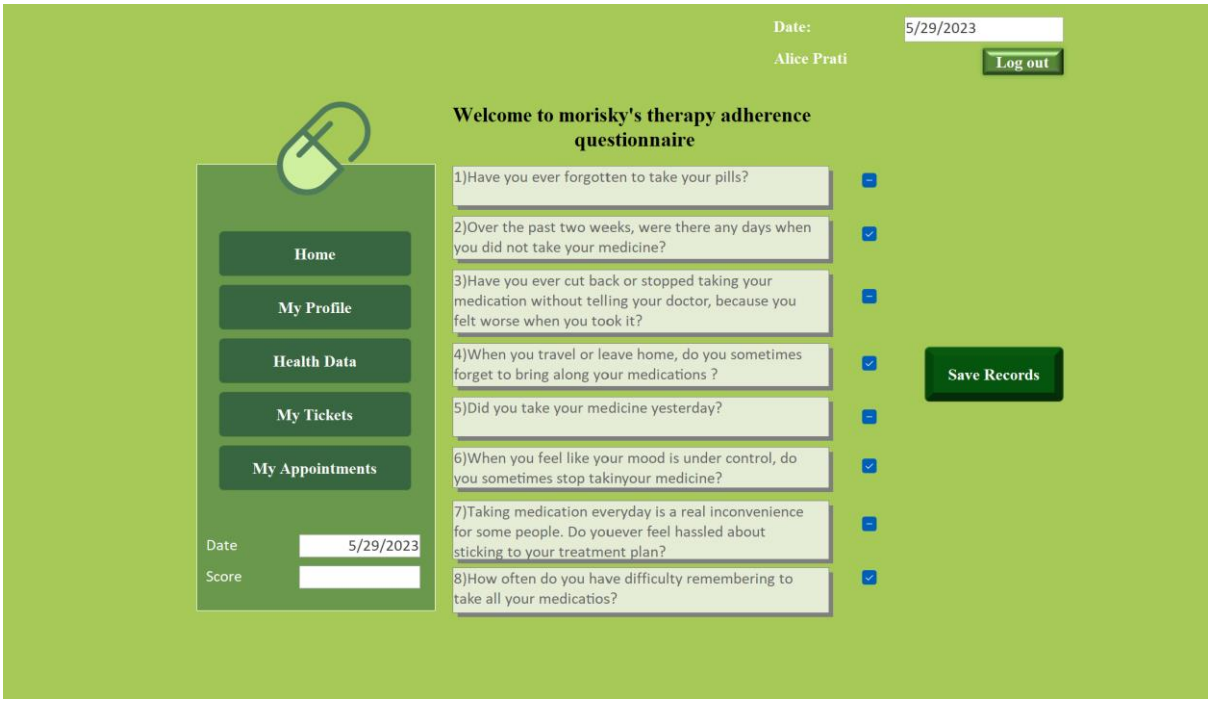


Figure 34: Therapy adherence questionnaire area

There is also a "Therapy Adherence" button on the "Health Data" page of the patient's profile. Clicking on this button redirects the patient to a new page that contains the Morisky's therapy adherence questionnaire (Fig.34). This questionnaire consists of a series of yes/no questions that the patient needs to answer based on their adherence to their therapy or treatment plan.

The questionnaire is designed to assess the patient's adherence to prescribed medications or therapies. Each question represents a specific behaviour or action related to therapy adherence, and the patient is required to answer each question by selecting either "yes" or "no" based on their own condition.

After the patient has provided their responses to all the questions, they can click on the "Save" button to save the questionnaire records. Once the records are successfully saved, a message will be displayed indicating the successful saving of the data.

The purpose of the "Therapy Adherence" feature is to assess and monitor the patient's adherence to their prescribed therapy or treatment plan. By providing a structured questionnaire, healthcare providers can gather valuable information about the patient's adherence behaviour and identify any potential challenges or areas for improvement.

Therapy adherence implementation:

As the previous part, we have used VBA codes in order to have the perfect output of our questionnaire with their accurate time and date.

```
Private Sub SaveRecord_Click()

    Dim db As DAO.Database
    Dim rs As DAO.Recordset
    Dim LoginID As Integer
    Dim fullName As String
    Dim Message As String
    Dim latestRecordID As Integer

    Set db = CurrentDb
    Set rs = db.OpenRecordset("Therapy_Adherence", dbOpenTable)
    LoginID = DLookup("ID", "login_data")

    If Not Me.TA_Q1.Value Or Not Me.TA_Q2.Value Or Not Me.TA_Q3.Value Or Not Me.TA_Q4.Value _
    Or Not Me.TA_Q5.Value Or Not Me.TA_Q6.Value Or Not Me.TA_Q7.Value Or Not Me.TA_Q8.Value Then
    MsgBox "Please select all checkboxes before saving.", vbInformation, "Incomplete Form"
    rs.Close
    db.Close
    Set rs = Nothing
    Set db = Nothing
    Exit Sub
    End If
    ' Update the field in the table based on the checkbox value
    rs.AddNew
    rs("Q1") = Me.TA_Q1.Value
    rs("Q2") = Me.TA_Q2.Value
    rs("Q3") = Me.TA_Q3.Value
    rs("Q4") = Me.TA_Q4.Value
    rs("Q5") = Me.TA_Q5.Value
    rs("Q6") = Me.TA_Q6.Value
    rs("Q7") = Me.TA_Q7.Value
    rs("Q8") = Me.TA_Q8.Value
    rs("PatientID") = LoginID
    rs.Update

    fullName = DLookup("Firstname & ' ' & Surname", "User", "User_ID=" & LoginID)
    latestRecordID = DMax("ID_THA", "Therapy_Adherence", "PatientID=" & LoginID)
    Me.TAScore = DLookup("Score", "Therapy_adherence", "ID_THA = " & latestRecordID)
    Message = "Dear " & fullName & "! Thanks for filling the therapy adherence form!your score is " & Me.TAScore.Value
    MsgBox Message
    ' Close the recordset and database objects
    rs.Close
    db.Close

    Set rs = Nothing
    Set db = Nothing
    DoCmd.Close acForm, Me.Name
    DoCmd.OpenForm "My_health_data"

End Sub
```

```
Private Sub Form_Load()
Dim LoginID As Integer
LoginID = DLookup("ID", "login_data")
Me.PatientID = LoginID
 fullName = DLookup("Firstname & ' ' & Surname", "User", "User_ID=" & LoginID)
    Me.loginName = fullName
End Sub
```

Figure 35: VBA code of therapy adherence questionnaire

The table in our database, named "Therapy_Adherence," contains all the questionnaires related to therapy adherence.

Therapy_Adherence

ID_THA	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	PatientID	AddTime	AddDate	Score
6	☑	☐	☐	☑	☐	☐	☑	☐	12	7:46:11 AM	5/22/2023	5
7	☑	☐	☑	☐	☑	☑	☑	☐	12	8:27:42 AM	5/22/2023	3
8	☑	☑	☑	☐	☐	☐	☐	☐	12	8:36:56 AM	5/22/2023	5
13	☐	☑	☑	☑	☐	☐	☐	☐	12	9:30:49 AM	5/22/2023	5
14	☑	☑	☑	☑	☑	☑	☐	☐	12	9:31:04 AM	5/22/2023	2
15	☑	☐	☑	☑	☑	☑	☑	☑	12	9:42:35 AM	5/22/2023	1
16	☐	☐	☐	☐	☑	☐	☐	☑	12	9:43:31 AM	5/22/2023	6
17	☑	☑	☑	☑	☑	☑	☑	☑	12	9:44:34 AM	5/22/2023	0

Figure 36: Therapy_Adherence table in access

6.3.4 Patient's appointments

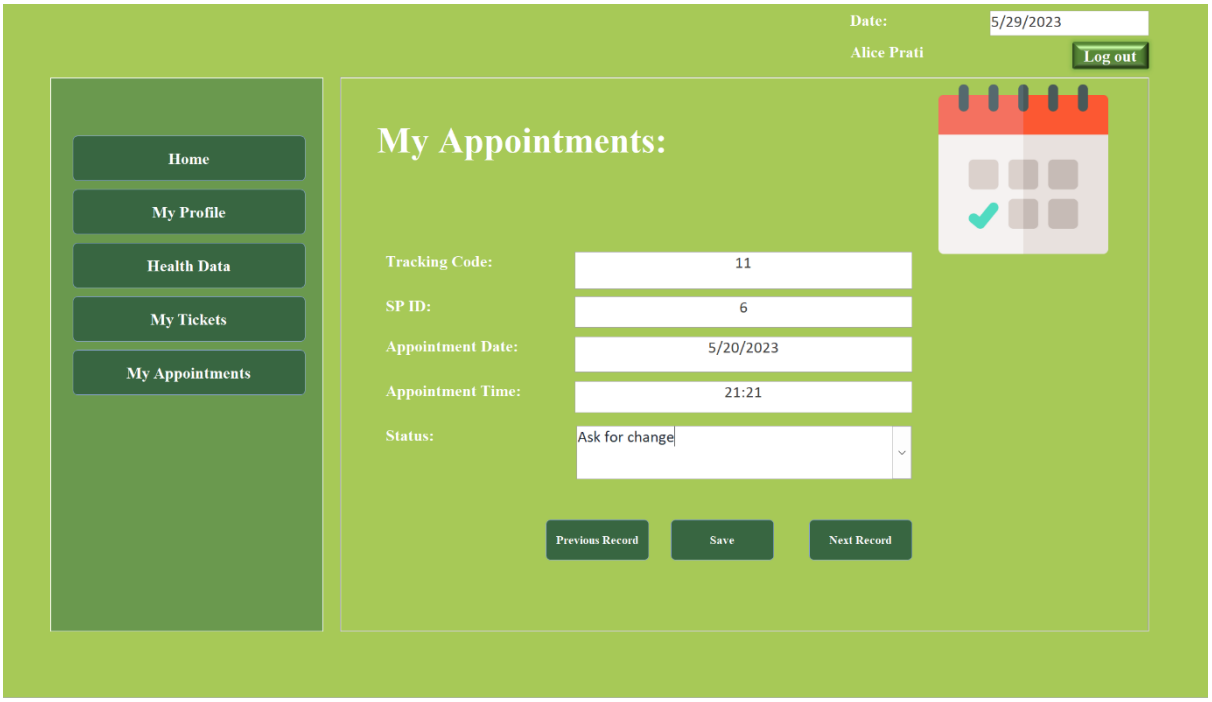


Figure 37: My Appointment area of patient

The "My Appointments" page within the patient's profile provides a convenient and organized overview of their scheduled appointments with specialized practitioners. Each appointment is displayed with essential details to ensure clarity and effective management. Firstly, a tracking code is assigned to every appointment, serving as a unique identifier that aids in tracking and referencing the appointment within the system.

Additionally, the appointment's date and time are prominently displayed, enabling patients to quickly determine when they are scheduled to see their specialized practitioner. This information helps patients plan their time and ensure they are available for the appointment.

Furthermore, the status of each appointment is indicated to provide a clear understanding of its progress. By default, new appointments from specialized practitioners are set to "pending" status. This signifies that the appointment is awaiting confirmation or further action from the patient. However, the patient has the flexibility to change the status of the appointment based on their preference. They can choose to mark it as "accepted" if they confirm their availability, "cancelled" if they need to reschedule or cancel the appointment or request a change if they require alterations to the appointment details.

To facilitate the communication between the patient and the specialized practitioner, a save button is provided for the patient to confirm any changes made to the appointment status. Once the patient clicks the save button, the updated status is reflected in the specialized practitioner's profile, ensuring both parties are aware of any modifications.

Additionally, the "My Appointments" page offers convenient navigation features for patients. Next and previous records buttons allow patients to easily navigate through their appointments, providing a seamless way to view past and future appointments without the need to leave the page.

My Appointments Implementation:

As mentioned in the Specialized Practitioner part, the Appointment table is field like below. In this part the system checks the User ID of the user that has logged in the system from login_data table with the P_ID part of the Appointment table and shows the appointment related to that patient. In this part the patient can change the status of the appointment.

Tracking_Co	P_ID	Appointment_Date	Appointment_Time	Status	SP_ID
11	5	5/20/2023	21:21	Ask for change	6
12	5	5/20/2023	20:20	Cancelled	6
13	5	5/17/2023	20:20	Confirmed	6
15	5	5/17/2023	19:19	Pending	6
16	5	5/1/2023	19:19	Pending	6
17	5	5/2/2023	5:05	Pending	6
18	5	5/18/2023	6:06	Pending	6
19	5	5/18/2023	6:06	Pending	6
20	5	5/18/2023	6:06	Pending	6
21	5	5/1/2023	4:04	Pending	6

Figure 38: Appointment table in access

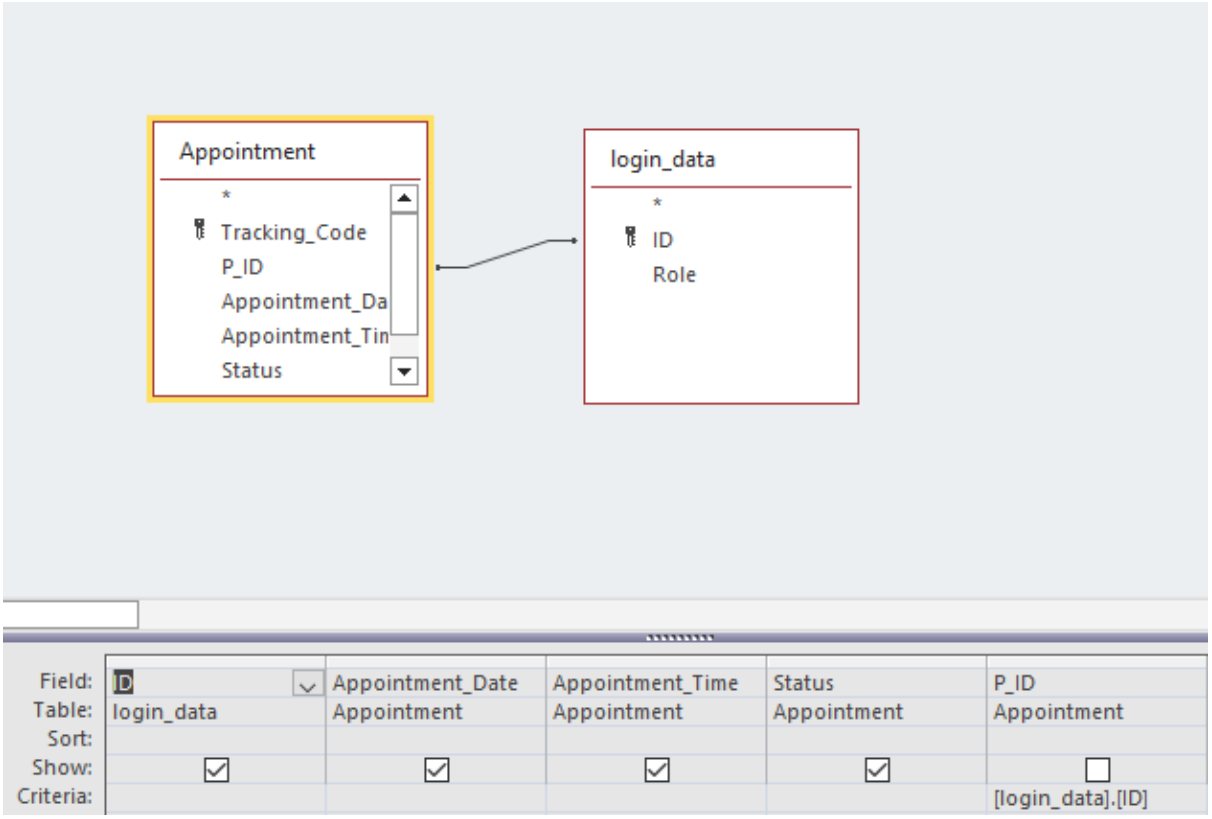


Figure 39: Appointment table and Login_data relationship

6.4 Technical Administrator's interface

6.4.1 TA's Profile

Figure 40: Patient's My Profile area

The user interface includes a "My Profile" button that the Technical Assistant can click on. When the user clicks on this button, it provides them with access to their personal data. It could lead to a dedicated page or section specifically designed to display and manage the user's information (Figure 40). After clicking on the "My Profile" button, the user is presented with their personal data. This includes fields such as Name, Contact information, Codice Fiscale, and any other relevant details associated with the user's profile. Within the personal data display, there is a "Modify" bellow the data.

Figure 41: Patient's profile editing area

The user can click on this button to enter the edit mode for their personal data (Figure 41). In this mode, the user gains the ability to edit any of their personal data fields. This could be achieved through text fields, drop-down menus, checkboxes, or other appropriate input methods based on the type of information being modified. After making the desired modifications, the user can save their changes by clicking on a "Save" button. This action confirms the modifications and updates the user's personal data accordingly.

6.4.2 Backup

One of the crucial tasks performed by the technical administrator is backing up various records stored in the system. These records are categorized into two main groups: "Medical Records" and "Personal Information." To accomplish this, the technical administrator can click on the "Backup" button, which directs them to a dedicated page for selecting the specific type of information they want to back up.

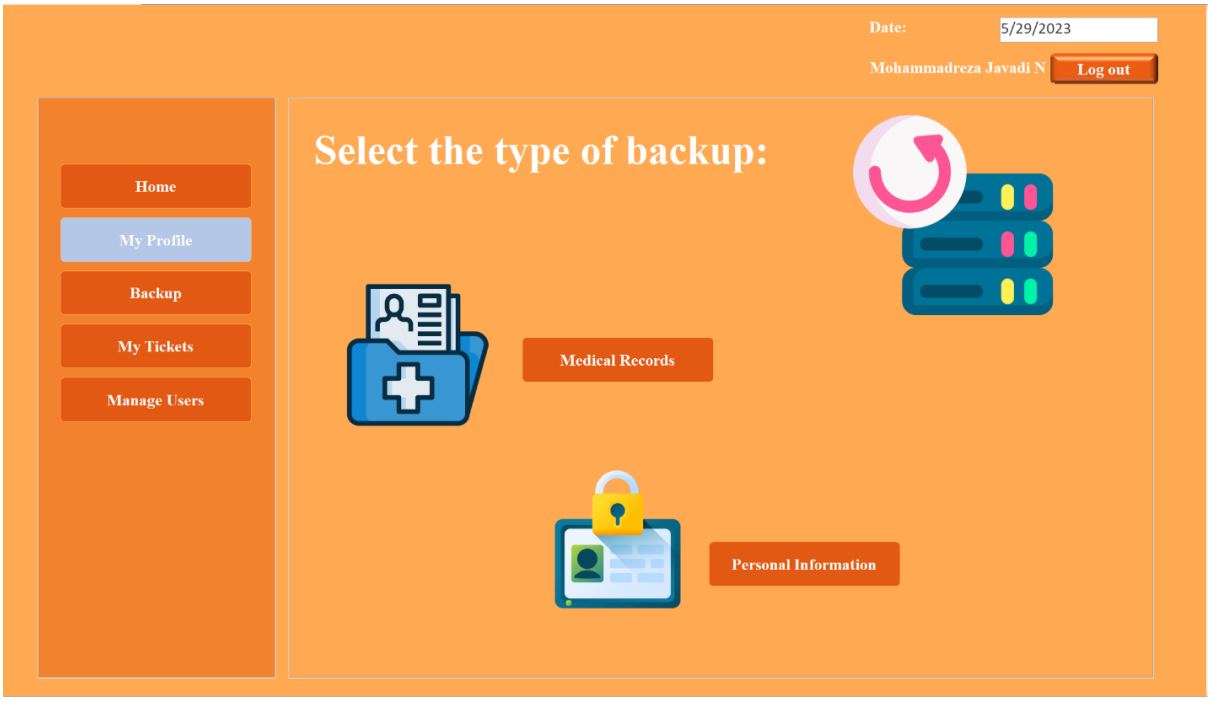


Figure 42: TA’s backup area

Once the backup type is selected, a new page is displayed where the technical administrator can choose the specific file that requires backup and the location where it should be saved.

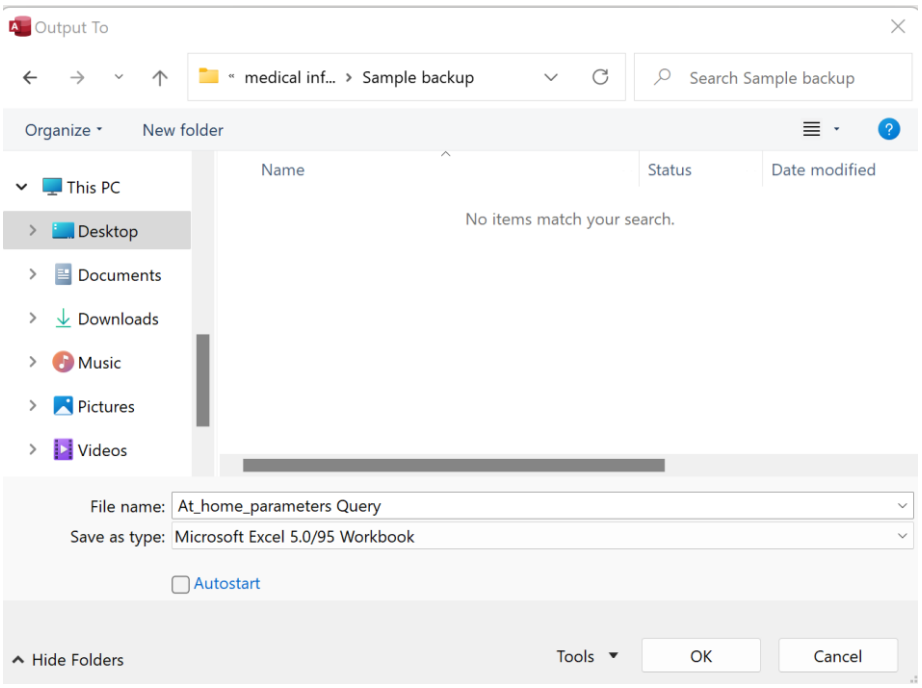


Figure 43: Area for choosing file and its location to be backed up

Backup Implementation:

The process involves using a macro code builder called "Export with formatting" to define the file saving format, which is configured as "Excel". This macro operates on various buttons, with each button associated with specific tables related to their names. For instance, when the personal information button is pressed, it exports the "User" and "LogT" tables. Afterward, a software message appears indicating that the backup has been successfully saved.

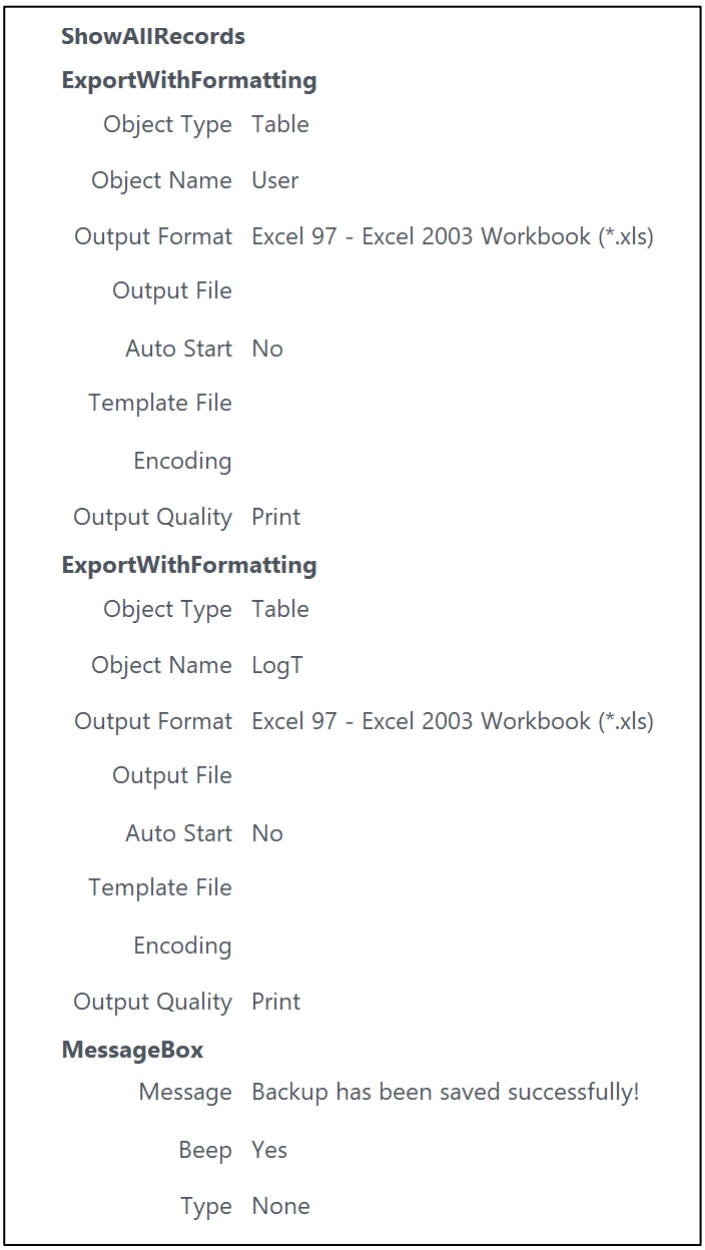


Figure 44: Macro code of Backup

Moreover, a similar process is carried out to back up medical records. A button is set up to export the following tables: "Appointment", "In_hospital_parameters", "Prescription", "At_home_parameters", "Questionnaire", "Therapy_Adherence", "Thresholds", and "Visit." Once these backups are completed, the software will display a message indicating the successful backup.

Additionally, it should be highlighted that privacy considerations play a crucial role when it comes to backing up medical reports. To ensure protection of sensitive patient data, it is critical that the backup process generates encrypted files. Unfortunately, our Microsoft Access version does not provide the capability to create encrypted backup files, and despite recognizing the significance of this matter, we have not being to achieve this goal.

As a final consideration, it was intended to record the timestamps of each backup in our database. However, due to time constraints during the project, this feature was not implemented.

6.4.3 Managing tickets:

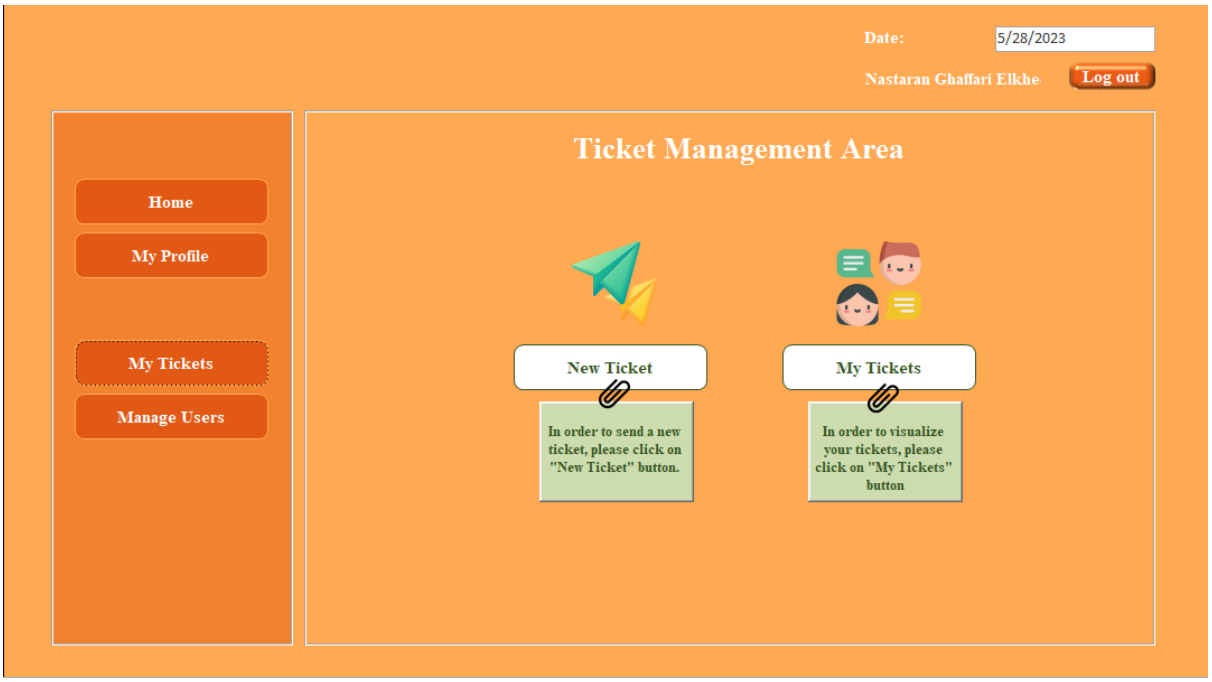


Figure 45: My Ticket area

There is also a "My Tickets" button in Home page, that the user can click on to access the ticket management section that the user can click on to access the ticket management section (Figure 45).

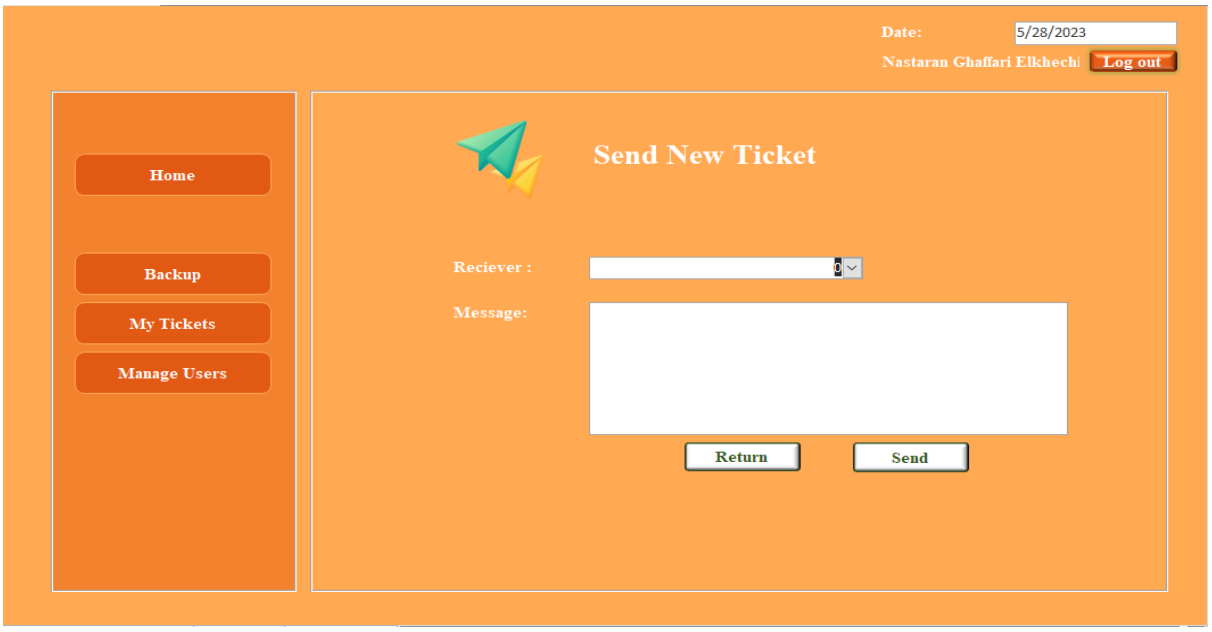


Figure 46: Area dedicated for composing and sending new ticket

Within the "My Ticket" section, there is a "New Ticket" button. Clicking on this button enables the user to create a new ticket. They can provide relevant information, such as receiver ID and the message text required to initiate a ticket request (Figure 46).

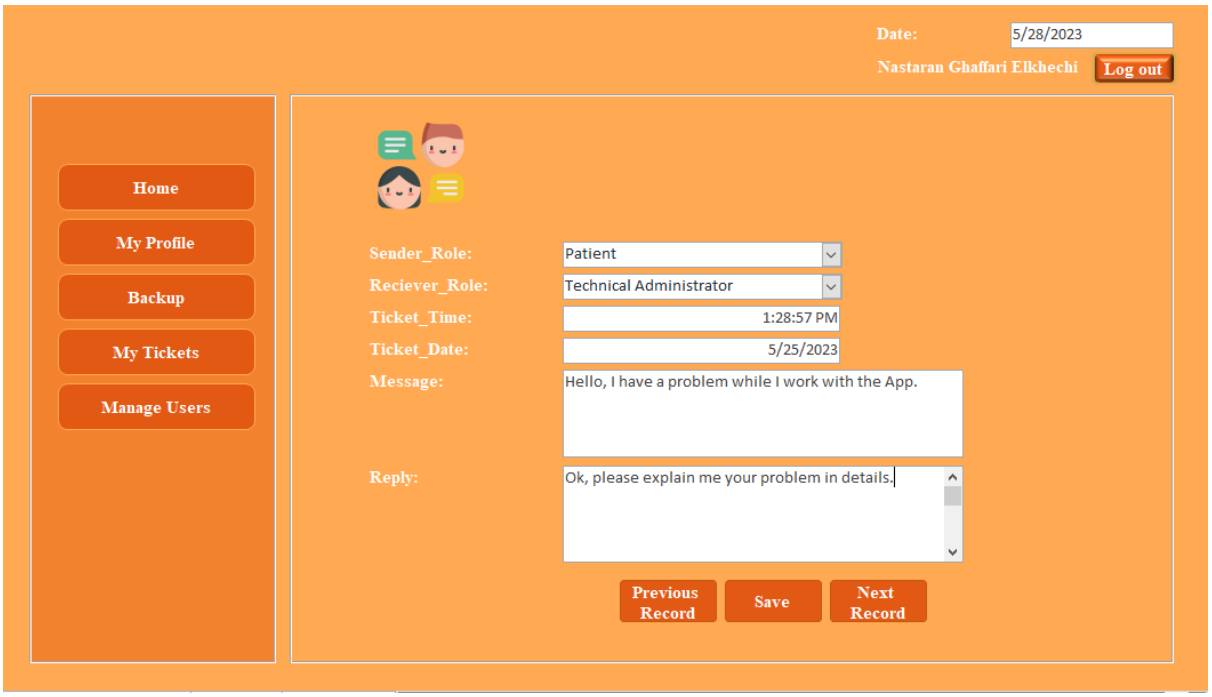


Figure 47: Area dedicated for observing received tickets

In the same "My Tickets" section, there is a "My Tickets" button. By clicking on this button, the user can access a list of their previous tickets. This list may include tickets that the user has sent or received. The user can select a specific ticket from the list to view its details. This includes information such as the Sender and Receiver role, sent Date and Time, and Message Content. Additionally, the user can reply to received tickets within this section.

It should be noted as sending and receiving ticket is an option considered for all the users, to avoid redundancy, its process is explained once above.

New Ticket Implementation:

In this part, the system saves the data in the login_data table in the Sender_ID part of the Ticket_1 table and also the date and time of the ticket.

```
    Dim Message As String
    Dim latestRecordID As Integer

    Set db = CurrentDb
    Set rs = db.OpenRecordset("Ticket_1", dbOpenTable)
    LoginID = DLookup("ID", "login_data")

    If IsNull(Me.msg) Or IsNull(Me.cmb_Re) Then
    MsgBox "Please fill in the fields.", vbInformation, "Incomplete Form"
    rs.Close
    db.Close
    Set rs = Nothing
    Set db = Nothing
    Exit Sub
    End If
    ' Update the field in the table based on the checkbox value
    rs.AddNew
    rs("Message") = Me.msg
    rs("Reciever_ID") = Me.cmb_Re.Column(0)
    rs("Reciever_Role") = Me.cmb_Re.Column(1)
    rs("Sender_ID") = LoginID
    rs("Ticket_Date") = Date
    rs("Ticket_Time") = Time()
    rs("Sender_Role") = DLookup("Role", "User", "User_ID=" & LoginID)
    rs.Update

    ' Close the recordset and database objects
    rs.Close
    db.Close

    Set rs = Nothing
    Set db = Nothing
    MsgBox " your ticket has been sent successfully!"
    'DoCmd.Close acForm, Me.Name
    'DoCmd.OpenForm "My_health_data"
End Sub
```

Figure 48: New ticket code

The system shows the users that the logged in user can send them ticket according to their role and show their data in a combo box.

My Ticket Implementation:

In this part, the system shows the tickets related to the specified Technical Administrator from the Ticket_1 table and the Technical Administrator can reply to the tickets but other fields are not editable and after pressing the save button, the reply is saved in the Ticket_1 table.

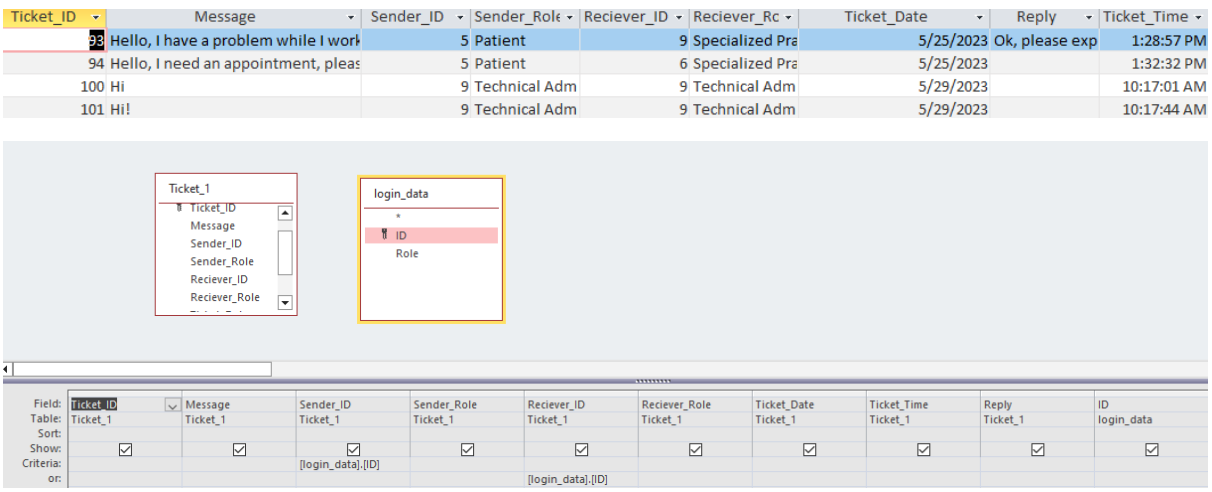


Figure 49: Ticket_ID table and relationship betweenTicket_1 and Login_data tables with its related query

6.4.4 Managing Users

One of the tasks performed by the technical administrator involves user management within the software. This includes adding new users to the system and searching for specific users. This functionality can be accessed by clicking on the "Manage Users" button. Upon opening the designated page, the technical administrator has the ability to search for a particular user by entering their ID. It's important to note that if the user is a patient, the technical administrator should select the "Search with Patient ID" option, while for a doctor, the "Search with Specialized Practitioner ID" should be chosen. It should be further emphasized that selecting one of these options will disable the ability to input text in the text box for the other option.
Additionally, if the technical administrator intends to add a new user to the system, they can make use of the "Create New Patient Profile" and "Create New SP Profile" buttons.

Figure 50: TA’s Manage Users area

When the Technical Administrator chooses the "Create New Patient Profile" option, they are directed to a dedicated page where they can input the necessary information pertaining to the patient. This page presents all the relevant fields and attributes related to patient, which can be filled in either by typing in the provided text boxes or by selecting options from the provided combo boxes. Once all the required data has been entered, the Technical Administrator can finalize the process by clicking on the "Save" button. By doing so, the new patient's is successfully added to the system as a user.

Figure 51: Area for adding new Patient as a user by TA

On the other hand, if the Technical Administrator selects the "Create New SP Profile" option, a dedicated page is displayed for entering the information of the new special practitioner. This page is specifically designed with attributes and fields tailored for doctors. The Technical Administrator can input the required data either by typing into the provided text boxes or by selecting options from the available combo boxes. After entering all the relevant information, the final step involves selecting the "Save" button. By doing so, the new doctor's details are successfully added to the software as a user.

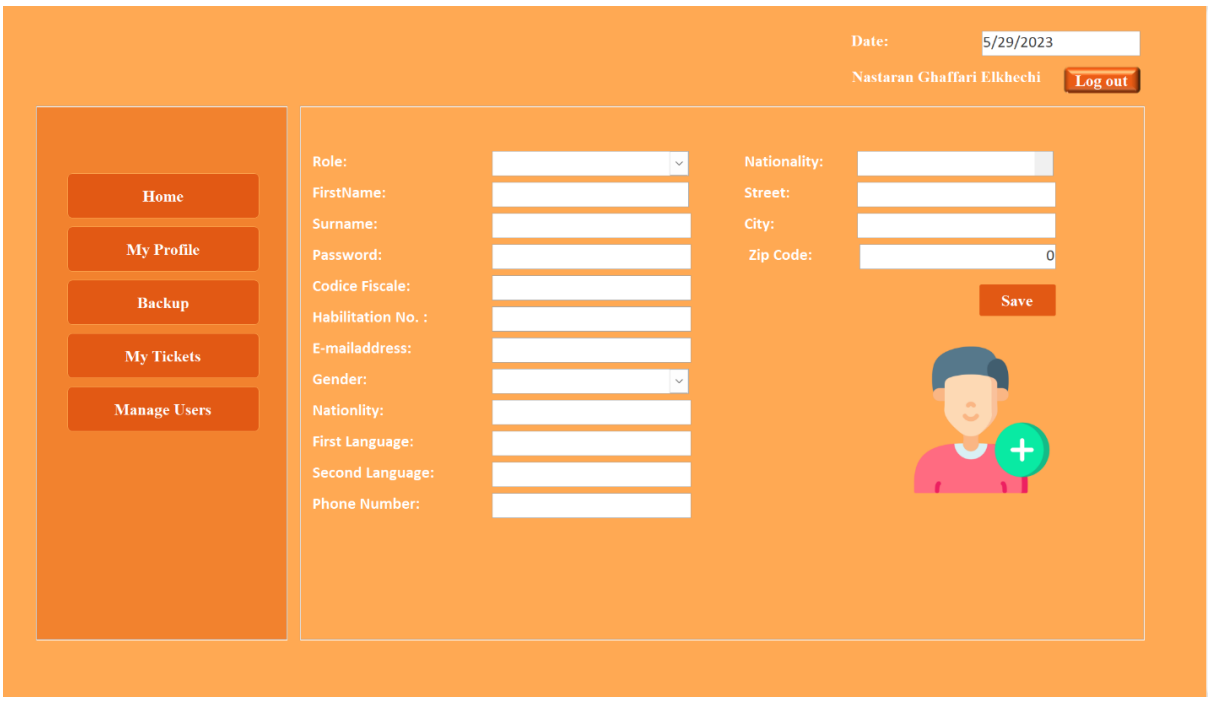


Figure 52: Area for adding new SP as a user by TA

6.5 Special Practitioner's Interface

6.5.1 Special Practitioner's my profile section

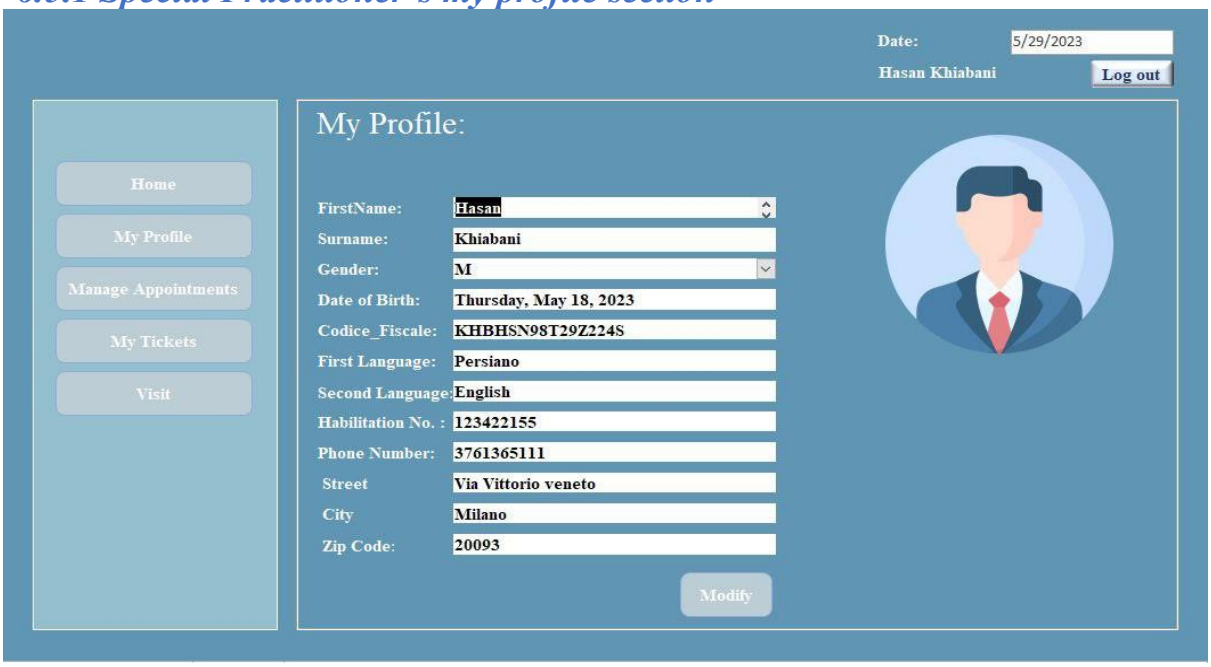


Figure 53: Special Practitioner's profile area

"My Profile" section, is a page on which doctors are able to observe their personal data, specifically tailored and dedicated to them. These data include: full name of the doctor, gender, date of birth, codice fiscal, primary and secondary language, habilitation number, phone number and address (street, city and zip code).

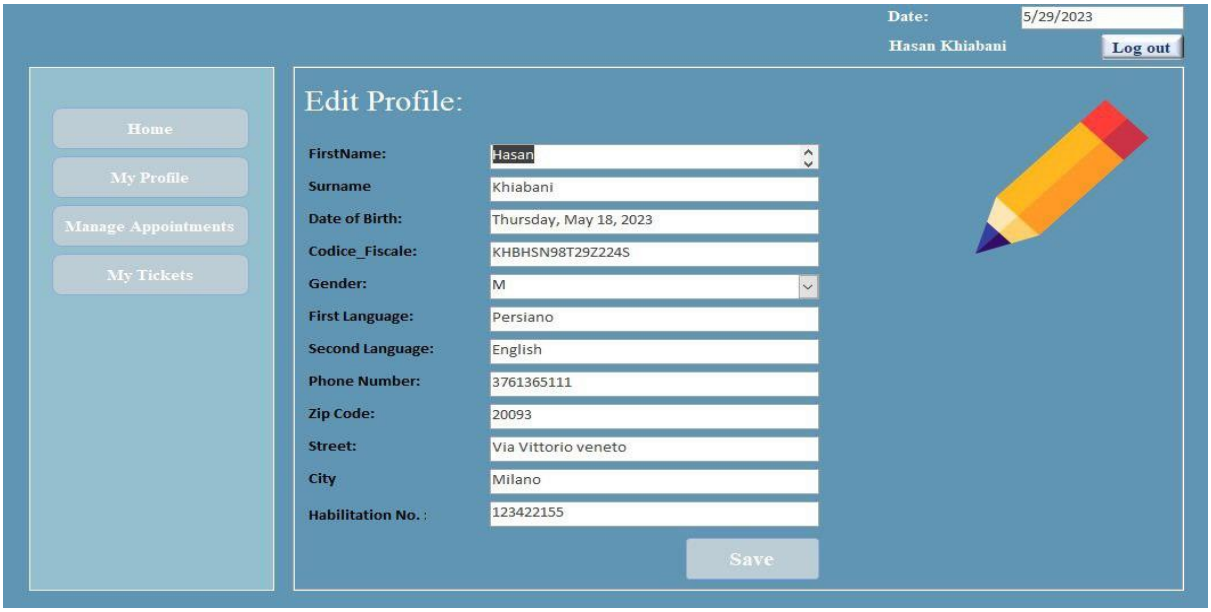


Figure 54: SP's Edit Profile area

By clicking on "Modify" button, a new page is opened on which special practitioner is able to change his personal data. Consequently, by selecting "Save" button, new data is recorded to the system.

6.5.2 Manage Appointments

One of the important responsibilities of a special practitioner involves managing their appointments which is accomplished by selecting the "My Profile" button. It leads to opening a dedicated page offering the doctor three distinct options for appointment management. These options are "My Appointments," "New Appointments," and "Change Request."

Figure 55: SP's Manage Appointment Area

When the doctor selects "My Appointments" button, they are directed to a page where they can view a comprehensive list of appointments that have already been scheduled. Within this list, the doctor can observe the patients' IDs, along with the respective dates and times of the appointments. Additionally, the status of each appointment is displayed. The status is determined based on the patient's actions, which may include Confirmed, Cancelled, or Asked for change.
If the patient has not yet determined the status of the appointment, it will be shown as "pending."

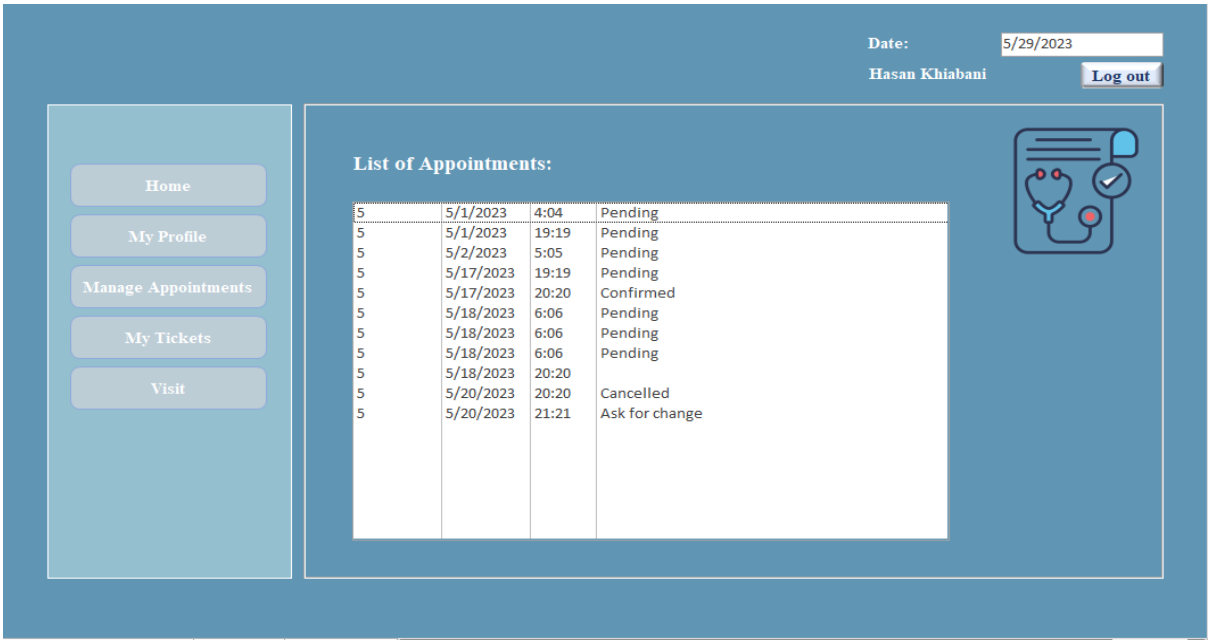


Figure 56: SP's list of appoitments

My Appointments Implementation:

```
Option Compare Database

Private Sub Detail_Click()

End Sub

Private Sub Form_Load()
Dim LoginID As Integer
    LoginID = DLookup("ID", "login_data")
    fullName = DLookup("Firstname & ' ' & Surname", "User", "User_ID=" & LoginID)
    Me.loginName = fullName
End Sub

Private Sub Command10_Click()
    Dim SQL As String
    Dim userName As String

    dayvis = Me.Text3
    dayvisit = Year(Me.Text3) & "-" & Month(Me.Text3) & "-" & Day(Me.Text3)
    SQL = "SELECT Tracking_Code, Surname, FirstName, [Codice_Fiscale], Appointment_Date, "
    Appointment_Time FROM Appointment, [User] WHERE User_ID = P_ID And SP_ID = Forms![P_login].u_txt And Appointment_Date=#" & dayvisit & "# ORDER BY Appointment_Ti

    DoCmd.RunSQL SQL
    Me.List13.RowSourceType = "Table/Query"
    Me.List13.RowSource = SQL
    DoCmd.Maximize

    Me.List13.ColumnCount = 6
    Me.List13.BoundColumn = 1
    Me.List13.ColumnWidths = "0in.;lin.;lin.;lin.;lin.;lin."
End Sub
```

Figure 57: Code for My Implementation of My Appointments

In this part, the system checks the Username of the Specialized Practitioner who has logged in the system from login_data table with the SP_ID in the Appointment table and shows the Appointments related to the user.

Tracking_Co	P_ID	Appointment_Date	Appointment_Time	Status	SP_ID
11	5	5/20/2023	21:21	Ask for change	6
12	5	5/20/2023	20:20	Cancelled	6
13	5	5/17/2023	20:20	Confirmed	6
15	5	5/17/2023	19:19	Pending	6
16	5	5/1/2023	19:19	Pending	6
17	5	5/2/2023	5:05	Pending	6
18	5	5/18/2023	6:06	Pending	6
19	5	5/18/2023	6:06	Pending	6
20	5	5/18/2023	6:06	Pending	6
21	5	5/1/2023	4:04	Pending	6

Figure 58: Appointment table in Access

Upon selecting the “New Appointment” button, a page is opened that enables the special practitioner to schedule a new appointment. To do so, the doctor must choose a specific patient from a combo box, which displays the name, surname, and fiscal code of their patients. By referring to the provided list of already booked appointment dates and times on this page, the doctor can determine the available slots and make a decision on the date and time for the new appointment. Finally, by clicking the “Save” button, the details of the new appointment are recorded in the system.

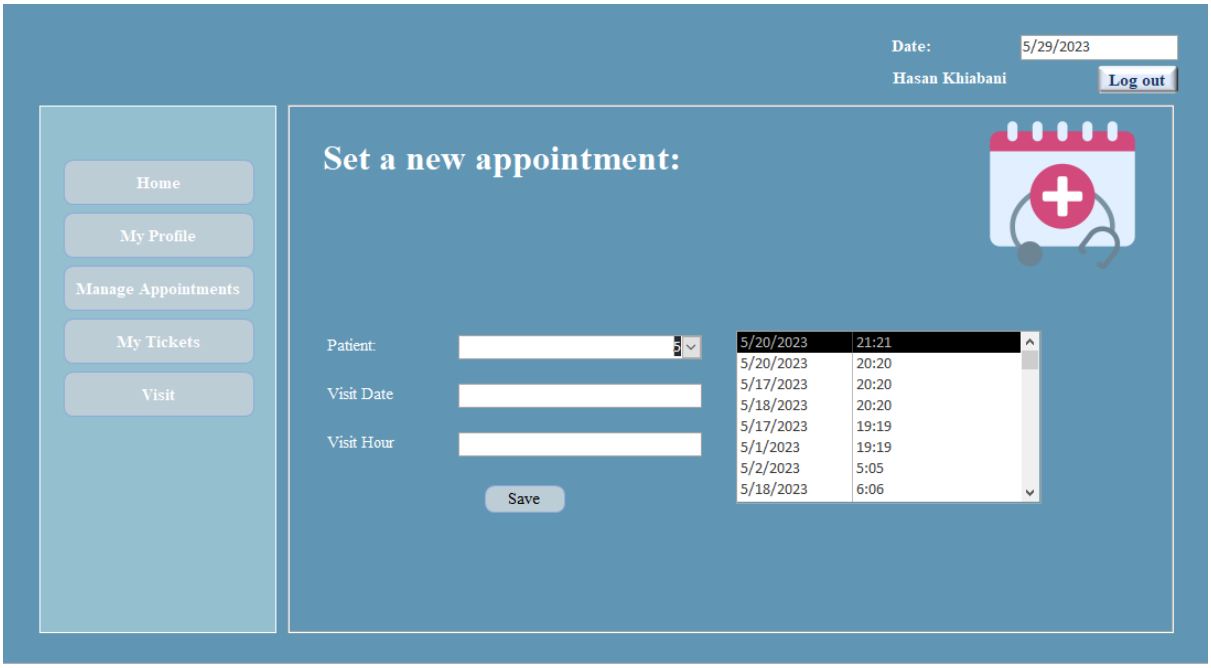


Figure 59: SP’s Area for setting a new appointment

Set a new Appointment Implementation:

In this part, the system checks to find the patients with a query and show the data related to them in a combo box.

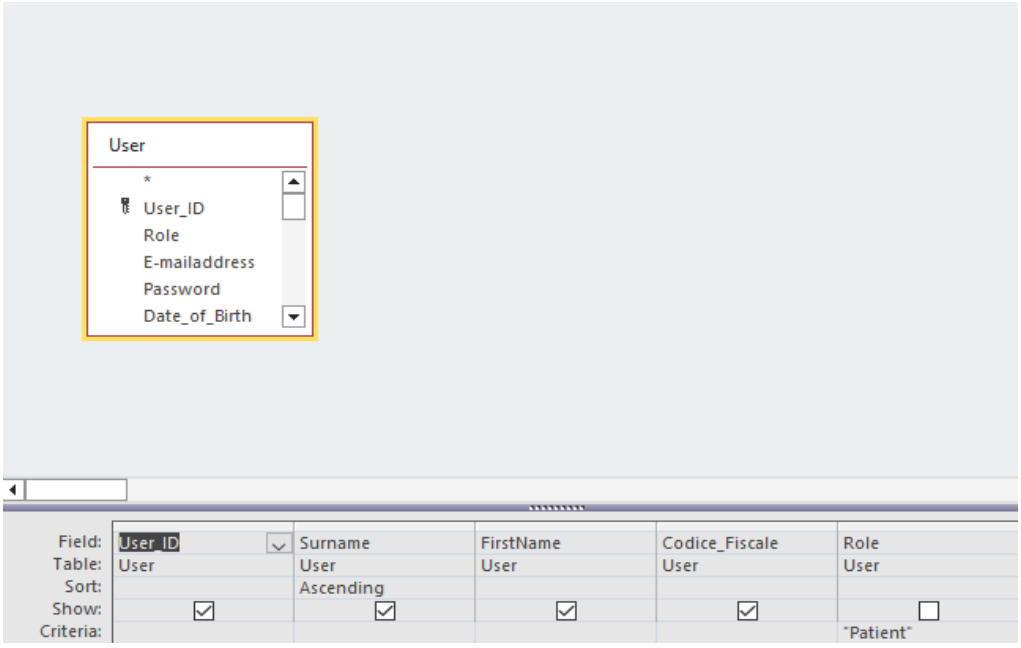


Figure 60

Also, the system has the information about the Specialized Practitioner who have logged in the system and checks for the appointments related to that Specialized Practitioner in the date that was chosen and show the time of that appointment in a combo box.

```
Option Compare Database

Private Sub Form_Load()
Dim LoginID As Integer
    LoginID = DLookup("ID", "login_data")
    fullName = DLookup("Firstname & ' ' & Surname", "User", "User_ID=" & LoginID)
    Me.loginName = fullName
End Sub

Private Sub Command16_Click()
SQL = "INSERT INTO Appointment( P_ID, Appointment_Date, Appointment_Time ) VALUES (" & Me.[Combo14] & ",'" & Me.[Text4] & "', '" & Me.[Text6] & "')"
DoCmd.RunSQL SQL

Set db = CurrentDb
    Set rs = db.OpenRecordset("Appointment", dbOpenTable)
    LoginID = DLookup("ID", "login_data")
    ' Update the field in the table based on the checkbox value
    rs.AddNew
    rs("SP_ID") = LoginID
    rs.Close
    db.Close
    Set rs = Nothing
    Set db = Nothing
    userName = LoginID
    dayvisit = Year(Me.Text4) & "-" & Month(Me.Text4) & "-" & Day(Me.Text4)
    SQL1 = "SELECT Tracking_Code, Appointment_Date, Appointment_Time FROM Appointment WHERE SP_ID =" & userName & " And Appointment_Date=#" & dayvisit & "# ORDER B

    Me.txtBusy.RowSourceType = "Table/Query"
    Me.txtBusy.RowSource = SQL1
    DoCmd.Maximize

    Me.txtBusy.ColumnCount = 3
    Me.txtBusy.BoundColumn = 1
    Me.txtBusy.ColumnWidths = "0in.;0in.;1in."


End Sub
```

Figure 61: VBA code for setting new appointment

Selecting "Change Request" button, enables special practitioner to modify the schedule of a specific appointment. This task is typically carried out when a patient requests a change for an appointment that was previously set by the doctor. To make the necessary changes, the doctor needs to enter the tracking code of the appointment, along with the patient's ID. Additionally, the doctor must specify a new date and time for the appointment to accommodate the request.

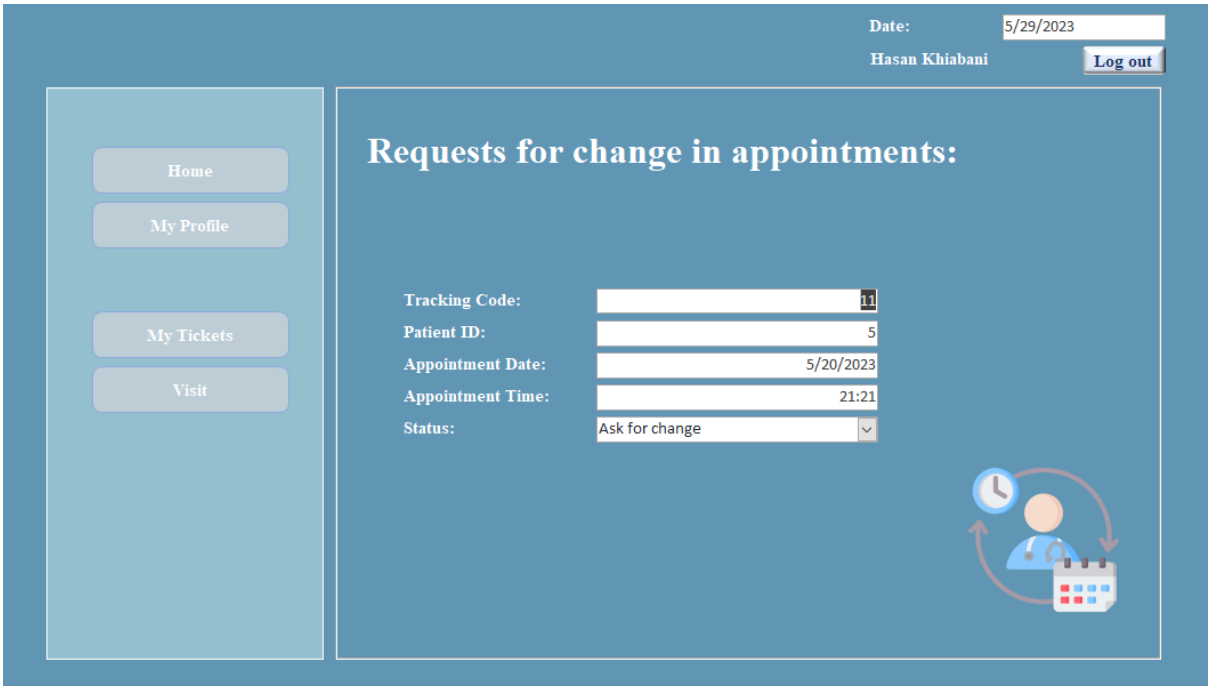


Figure 62: SP’s area for changing appointment schedule

Ask For Change Implementation:

In this part, first the system checks the status of appointments of the Specialized Practitioner who has logged in the system in the Appointment table to find the 'Ask For Change' status with a query. Then Shows the related data to the Specialized Practitioner to decide what to do.

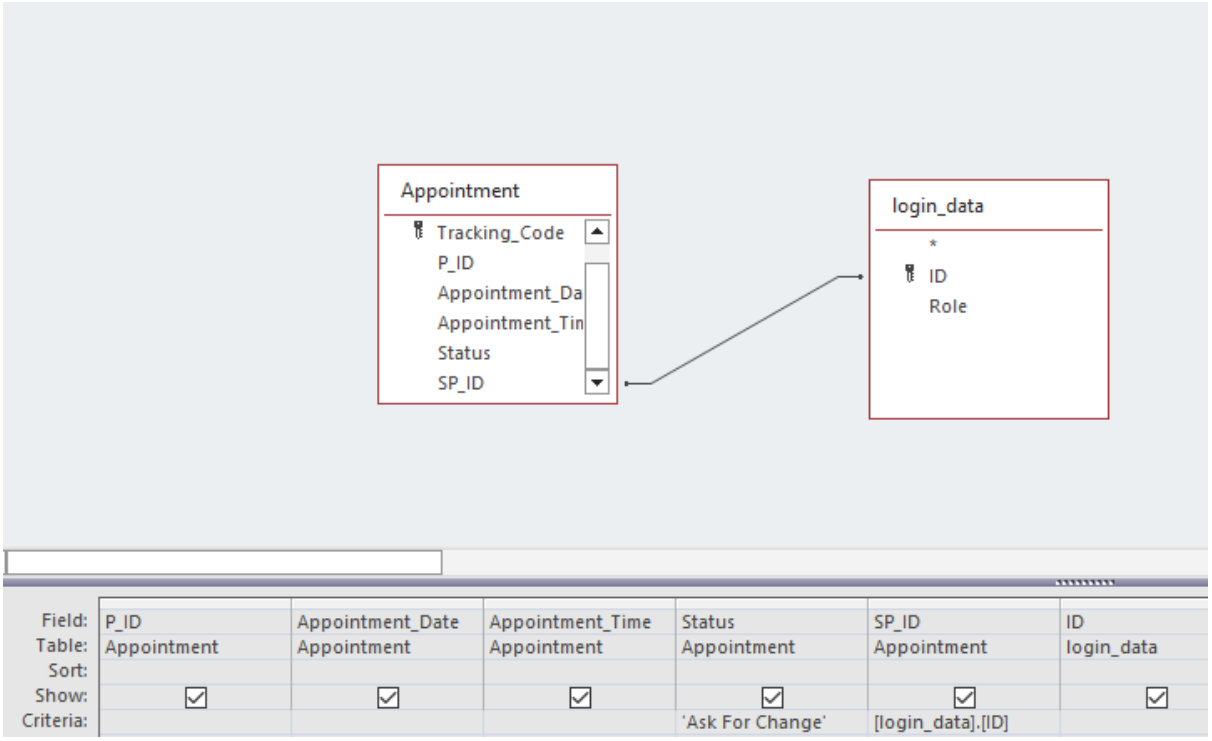


Figure 63: Relationship between Appointment and Login_data tables with its relevant query

6.5.3 Visit

Figure 64: SP's Visit area

During the visit session, the specialized practitioner utilizes a software to navigate to the visit page by clicking on the Visit button. This grants the specialized practitioner the ability to select the patient who had an appointment on that specific date and determine the status of the visit. To choose a patient, the software provides a convenient combo box that displays the Patients' Name, Surname, and Codice Fiscale. Once a specific patient is selected, the specialized practitioner can proceed to the status combo box, which offers three options: Present, Completed, and Cancelled.
When a patient is physically present during the visit, their status is set as "Present." However, if the patient misses the session, their status is marked as "Cancelled." It's important to note that although the "Completed" option is available in the status combo box, selecting it at this stage of the visit triggers a warning error. This reminder prompts the specialized practitioner to refrain from choosing this status option until the appropriate stage.
Moreover, by choosing "Present", start time and date of the visit is recorded in "visit" Table of Access in the relevant fields.

Visit

Tracking_Cod	Patient_ID	SP_ID	Visit_Date	Start_Time	End_Time	Status
201	12	6	28-May-23	4:51 PM	17:07	Completed
202	12	6	28-May-23	5:08 PM	17:08	Completed
206	12	6	29-May-23	4:57 PM	16:59	Completed
208	12	6	30-May-23	10:37 PM	22:38	Completed
209	12	6	01-Jun-23	10:50 AM		Cancelled
211	14	6	01-Jun-23	11:28 AM		Present
(New)	0	0				

Figure 65: Visit table in Access

The row indicating the "present" status indicates that the patient is currently attending a visit session that is still in progress. In the image provided, there are no specific fields available for entering the IDs of the specialized practitioner or patient. However, these IDs will be automatically saved in our database once the user logs in and selects the appropriate options from the Combo-Box.

```
Private Sub Combo13_AfterUpdate()
    Dim selectedValue As Variant
    selectedValue = Me.Combo13.Value

    ' Update the existing record in the table with the selected value
    Dim db As DAO.Database
    Dim rs As DAO.Recordset
    Set db = CurrentDb
    Set rs = db.OpenRecordset("visit_data", dbOpenDynaset)

    If Not rs.EOF Then
        rs.Edit
        rs("ID") = selectedValue
        rs.Update
    End If

    rs.Close
    Set rs = Nothing
    Set db = Nothing

End Sub
```

```
Private Sub Command15_Click()
    Dim SPID As Variant
    SPID = DLookup("ID", "login_data")
    Me.SP_ID.Value = SPID




    Dim Status As String
    SLaLus = Me.SLaLus.Value

    If Status = "Present" Then
        DoCmd.GoToRecord , "", acNewRec
        If (MacroError <> 0) Then
            Beep
            MsgBox MacroError.Description, vbOKOnly, ""
        End If
        DoCmd.OpenForm "SP_Vis_PHQ9", acNormal, "", "", , acNormal
        DoCmd.Close acForm, "Visit"
    ElseIf Status = "Cancelled" Then
        DoCmd.OpenForm "SP_MNG_Area", acNormal, "", "", , acNormal
        DoCmd.Close acForm, "Visit"
        MsgBox "The visit has been cancelled successfully.", vbOKOnly, ""

    ElseIf Status = "Completed" Then
    MsgBox "Warning: You are not allowed to set this status for the appointment in this Step of Visit.", vbOKOnly, ""
    End If

End Sub
```

```
Private Sub Form_Load()
Dim LoginID As Integer
    LoginID = DLookup("ID", "login_data")
    fullName = DLookup("Firstname & ' ' & Surname", "User", "User_ID=" & LoginID)

    Me.loginName = fullName
End Sub
```

Figure 66: VBA code of Visit

These codes are a combination of Macros and Visual basics code. For this performance we use macros and then use convert macros to VBA and then put the codes between our codes. There were some difficulties to doing so but it was needed to have the best performance.

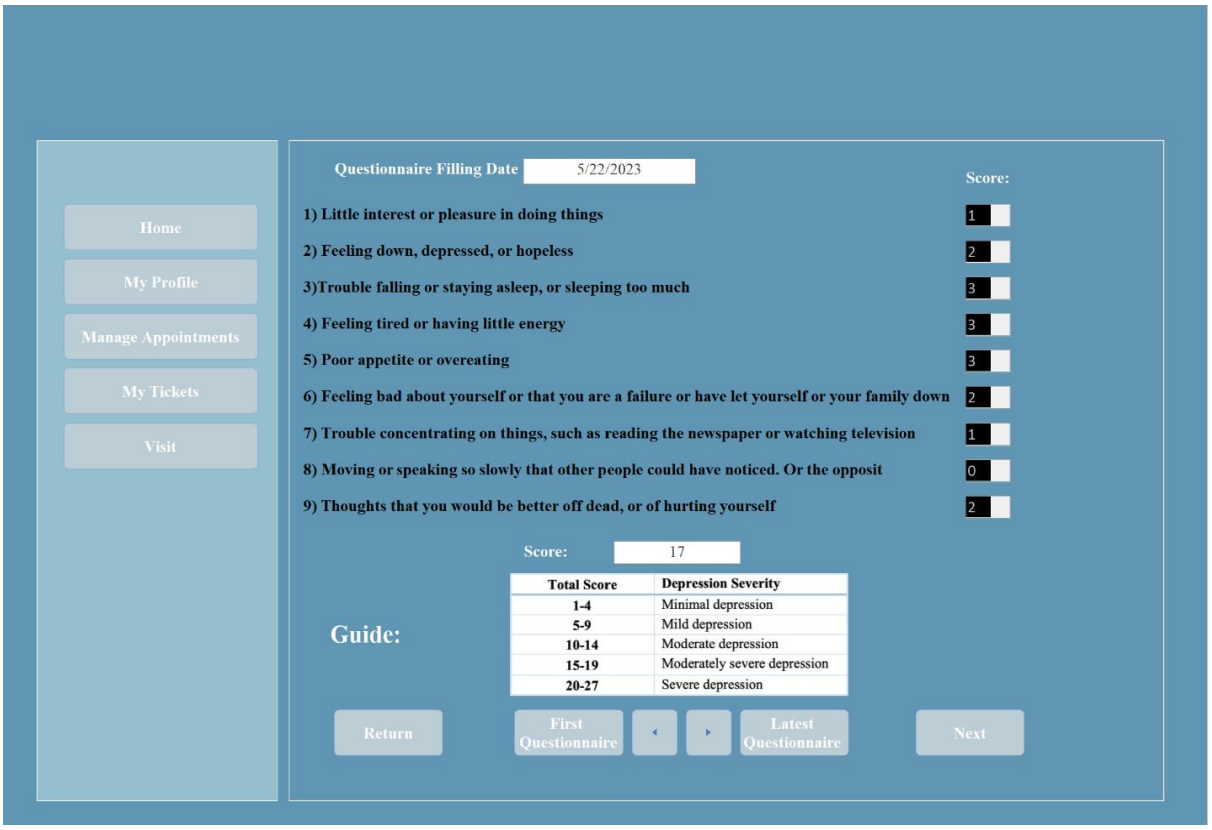


Figure 67: Area for observation PHQ9 questionnaire and results by SP

If patient being present, by pressing the “Next” button, the doctor is guided to the filled PHQ9 questionaries page by the patient went to visit.
The PHQ-9 (Patient Health Questionnaire-9) is designed to assess and measure the severity of depressive symptoms in individuals and is filled by the patient at home. It consists of nine questions asking patient to rate the frequency of certain depressive symptoms they have experienced over the past two weeks. Each question is scored on a scale from 0 to 3, with higher scores indicating more severe symptoms. The total score, ranging from 0 to 27, provides an overall assessment of the individual's depressive symptomatology.
additionally, previous and next button, enables doctors to navigate between questionnaires filled out on different dates, allowing for easy access to subsequent and previous questionaries. In this case, doctor is able to compare between different questionaries and analyze progress of patient’s condition.

To implement this functionality in MS Access, we utilized a form that retrieves all the questionnaires associated with a patient visit using an inner query. The inner query is responsible for retrieving data from the questionnaires table where the patient ID matches the selected patient in the initial visit step.

```
SELECT Questionnaire.IDQuestionnaire, Questionnaire.Patient_ID, Questionnaire.QNTime, Questionnaire.QNDate, Questionnaire.Q1, Questionnaire.Q2, Questionnaire.Q3, Questionnaire.Q4, Questionnaire.Q5,
Questionnaire.Q6, Questionnaire.Q7, Questionnaire.Q8, Questionnaire.Q9, Questionnaire.Score, visit_data.ID
FROM Questionnaire INNER JOIN visit_data ON Questionnaire.Patient_ID = visit_data.ID
WHERE (((Questionnaire.Patient_ID)=[visit_data].[ID]));
```

Figure 68: PHQ9 questionnaire code

In this step, the fields are locked to prevent specialized practitioners from editing the data.

Figure 69: area for observing Morisky's therapy adherence results by SP

By clicking the "Next" button, Morisky's Therapy Adherence Questionary with its results that has being filled by patient at home, is displayed. The aim of this questionary is to assess the adherence of patients to their prescribed medication regimen. It consists of a series of questions that evaluate various factors related to medication adherence.
In our software we used 8 question version of this questionnaire focus on different aspects of medication adherence, such as forgetfulness, understanding of the prescribed regimen, and the patient's behaviour in taking medications.
Each question is scored based on the patient's response, with higher scores indicating lower adherence to the medication. Like for the former questionnaire there are previous and next buttons, for moving among ones filled in different dates.

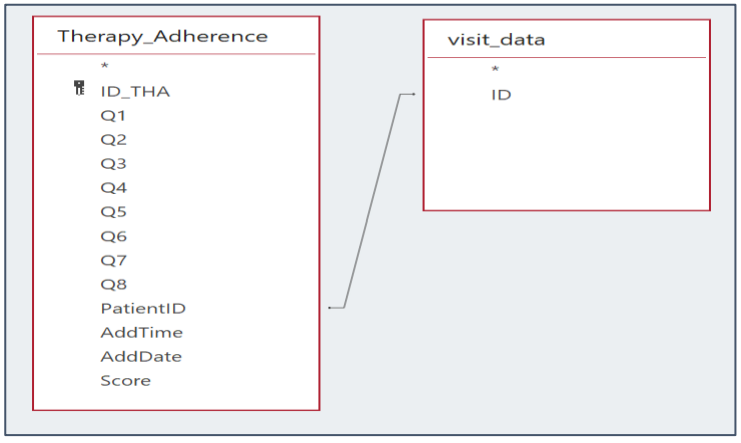


Figure 70: Realtionship of Therapy_adherance and Visit_data tables

The implementing procedure and SQL codes are the same as the previous part.

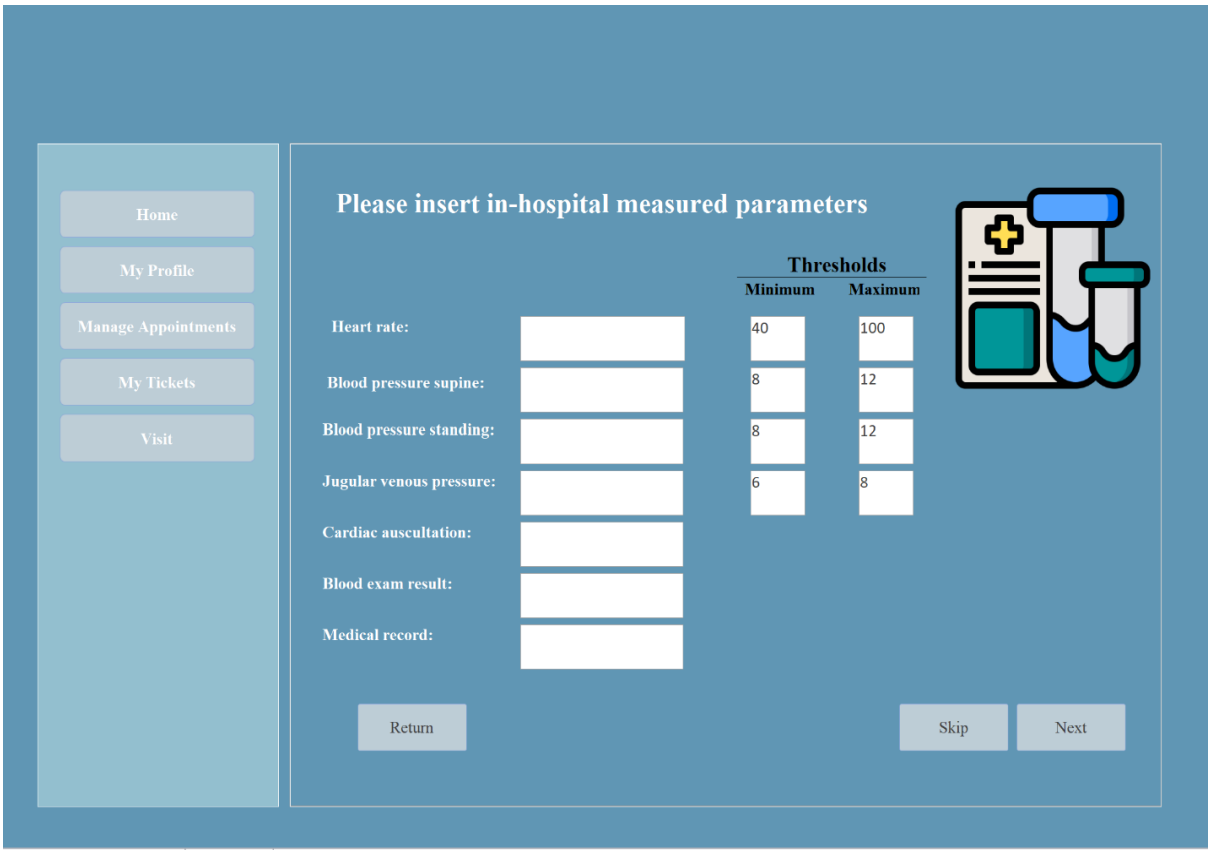


Figure 71: Area for entering In-Hospital Parameters by SP

Upon selecting the "Next" button, a page for inputting "in-Hospital" parameters is displayed. It enables doctor to upload the parameters that are measured during the visit manually or in file format. The parameters encompass a range of vital indicators, including Heart rate, Blood pressure in supine and standing position, Jugular venous pressure, Cardiac auscultation, Blood exam results, and the patient's medical record. Furthermore, for each parameter, there are minimum and maximum thresholds that can be adjusted for the patient in subsequent steps. Additionally, if no parameters are measured during the visit, special practitioner has the option to bypass this page by selecting the "Skip" button.

In this form, we encountered some challenges as we needed to have certain fields filled out by the specialized practitioner. Additionally, we wanted to display the thresholds specific to the selected patient from the "Thresholds" table. To address these requirements, we took several steps.

For the blank fields, which are associated with the "in-hospital" table, we set the control source accordingly and enabled data entry by setting the "Data Entry" property to "Yes." This allowed the specialized practitioner to insert new data into the table through these fields.

To retrieve and display the relevant thresholds from the corresponding table, we utilized VBA codes. These codes enabled us to fetch the necessary threshold information and present it in the form for the selected patient.

```
Private Sub Command21_Click()

    On Error Resume Next
    Dim SPID As Variant
    SPID = DLookup("ID", "login_data")
    Me.SP_ID.Value = SPID

    Dim PID As Variant
    PID = DLookup("ID", "visit_data")
    Me.Patient_ID.Value = PID

    DoCmd.GoToRecord acTable, "In_hospital_parameters", acNewRec
    If (MacroError <> 0) Then
        Beep
        MsgBox MacroError.Description, vbOKOnly, ""
    End If
    DoCmd.Close acForm, "In_hospital_parameters"
    DoCmd.OpenForm "visit2", acNormal, "", "", , acNormal

End Sub


Private Sub Form_Load()
Dim VisitID As Integer
VisitID = DLookup("ID", "visit_data")
Me.Text27.Value = DLookup("HR_Min", "Thresholds", "Patient_ID=" & VisitID)
Me.Text36.Value = DLookup("HR_Max", "Thresholds", "Patient_ID=" & VisitID)
Me.Text29.Value = DLookup("BP_Min", "Thresholds", "Patient_ID=" & VisitID)
Me.Text56.Value = DLookup("BP_Min", "Thresholds", "Patient_ID=" & VisitID)
Me.Text38.Value = DLookup("BP_Max", "Thresholds", "Patient_ID=" & VisitID)
Me.Text55.Value = DLookup("BP_Max", "Thresholds", "Patient_ID=" & VisitID)
Me.Text32.Value = DLookup("JVP_Min", "Thresholds", "Patient_ID=" & VisitID)
Me.Text40.Value = DLookup("JVP_Max", "Thresholds", "Patient_ID=" & VisitID)


End Sub
```

Figure 72: VBA code for In-Hospital Parametrs entering

ID		Blood_pressure_sup	Blood_pressure_st	Jvp	Cardiac_aus			Patient_ID	SP_ID	Date	Time
2	(0)	8	9	102	123	(0)	(0)	13	6	5/23/2023	13:14
8	(0)	12	12	100	120	(0)	(0)	14	6	5/24/2023	18:53
20	(0)		11	97	133	(0)	(0)	14	6	5/25/2023	10:12
(New)	(0)					(0)	(0)	0	0		

Visit | In_hospital_parameters | In_hospital_parameters | **Thresholds**

Patient_ID	SP_ID	HR_Min	HR_Max	BP_Min	BP_Max	Weight_Mi	Weight_Ma	GL_Min	GL_Max	JVP_Min	JVP_Max	Date	Time
12	6	40	100	8	12	60	80	100	125	6	8	5/23/2023	0:00
13	6	60	100	8	12	60	80	100	125	6	8	5/23/2023	0:00
14	6	40	100	8	12	60	80	100	125	6	8	5/23/2023	0:00
0	0												

Figure 73: In-hospital_parameters and Thresholds tables

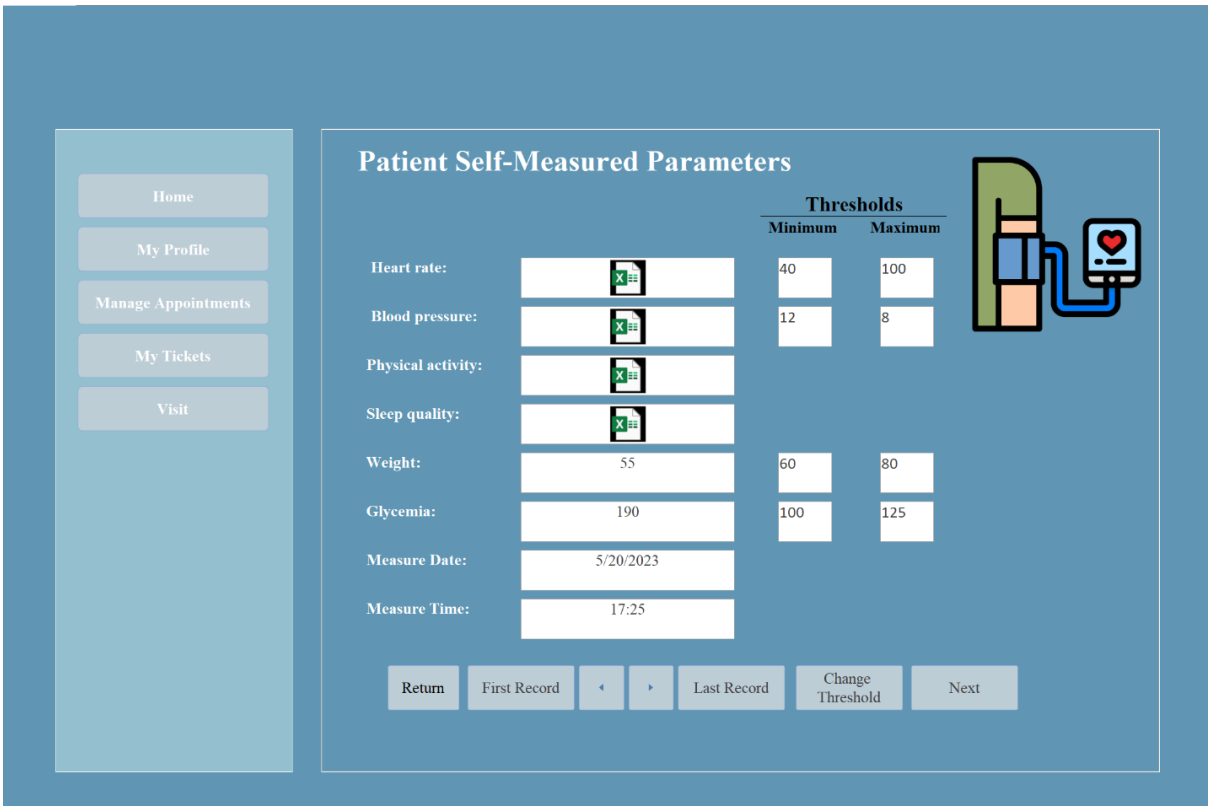


Figure 74: Area for observation parameters measured by patient at home

By selection of the “Next” button, doctor is guided to “Patient Self-Measured Parameters” page. It consists of parameters that patient measured at home and entered manually or in file format to the software. It includes variables such as Heart rate, Blood pressure, Physical activity, sleep quality, Weight, Glycemia, Measure Date and Measure Time. There are also and buttons for navigation of doctor between parameters measured in subsequent and previous dates alternatively.

Figure 75: Area for thresholds alteration by SP

Moreover, there are minimum and maximum thresholds for vital and health related parameters which can be adjusted for each patient. It is possible by selecting “Change Threshold” button, which opens a new page for tailoring threshold by doctor. It is due to the fact that for each patient based on their age, gender, medical history and specific treatment plans, distinct thresholds should be defined.

In this step, all the fields have been populated with data retrieved from the "Thresholds" table, and the software allows changes to be made to the fields where the patient ID matches. To facilitate rewriting the data in the table, a "Save Data" macro has been implemented. This macro enables the user to save any modifications made to the fields and update the corresponding records in the "Thresholds" table.

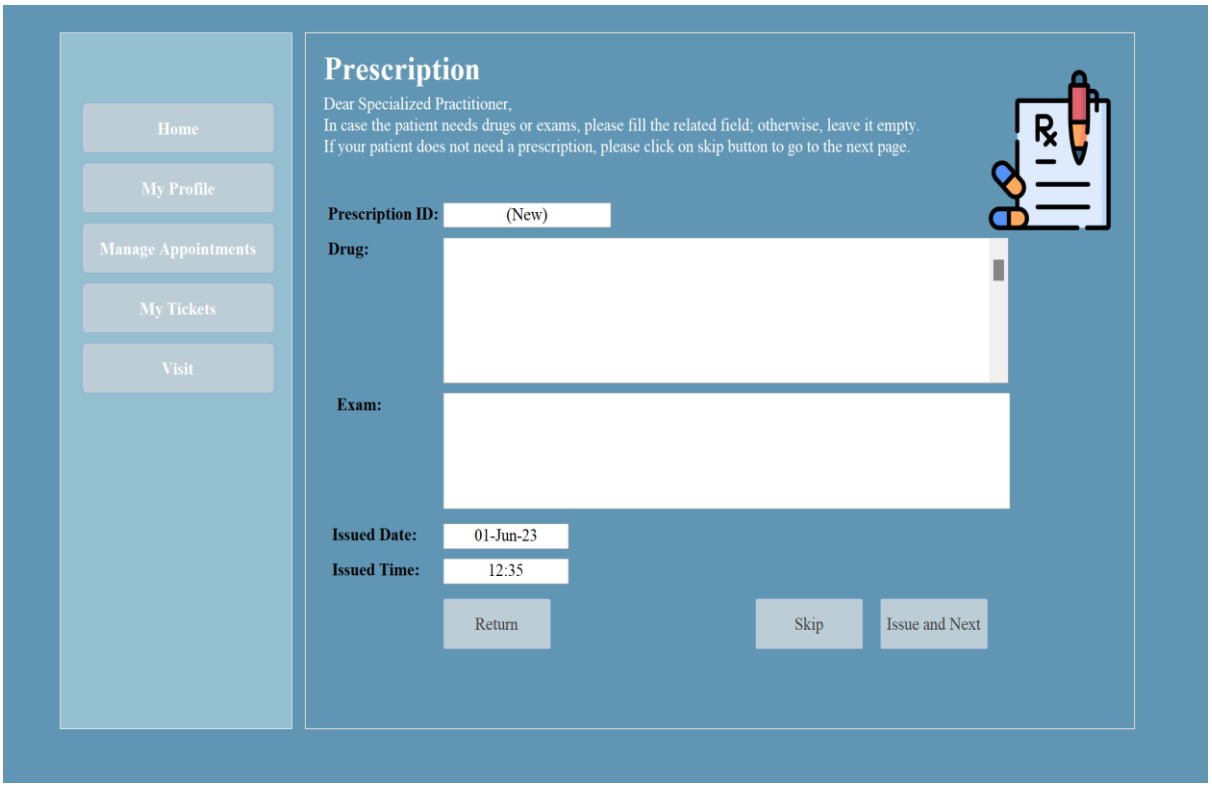


Figure 76: Area for entering new prescriptions for patient by SP

Upon reviewing the parameters measured by the patient at home, selecting the "Next" button leads to appearance of the "Prescription" page. Here, the doctor has the opportunity to enter specific information regarding any newly required medications or examinations for the patient. However, as not every patient necessarily requires new medication or examinations, the doctor can choose to skip this page by selecting the "Skip" button. In the case that the doctor does prescribe new medication or examinations, clicking the "Issue and Next" button generates a printable prescription for the doctor.

Visit | In_hospital_parameters | Thresholds | Prescription | **Prescription**

Prescription_ID	Patient_ID	SP_ID	Drug	Exam	Issued Date	Issued Time
25	14	6	Amo225		25-May-23	11:12
26	14	6	Amo223		25-May-23	11:18
30	14	6	Amoxi225		25-May-23	12:33
31	14	6	Amoxi225		25-May-23	12:35
41	14	6	Medication: Lithium C	General Blood E	25-May-23	16:39
42	12	6	Omeprazole 20 mg on	General Blood e	28-May-23	13:10
43	12	6	Omeprazole 20 mg on		28-May-23	13:19
44	12	6	Medication: Acetamin	Blood Exam	28-May-23	13:24
45	12	6			28-May-23	14:26
46	12	6			28-May-23	15:03
47	12	6			28-May-23	15:03
48	12	6	Acetaminophen 325 m	General Blood E	28-May-23	15:13
(New)	0	0				

Figure 77: Prescription table in access

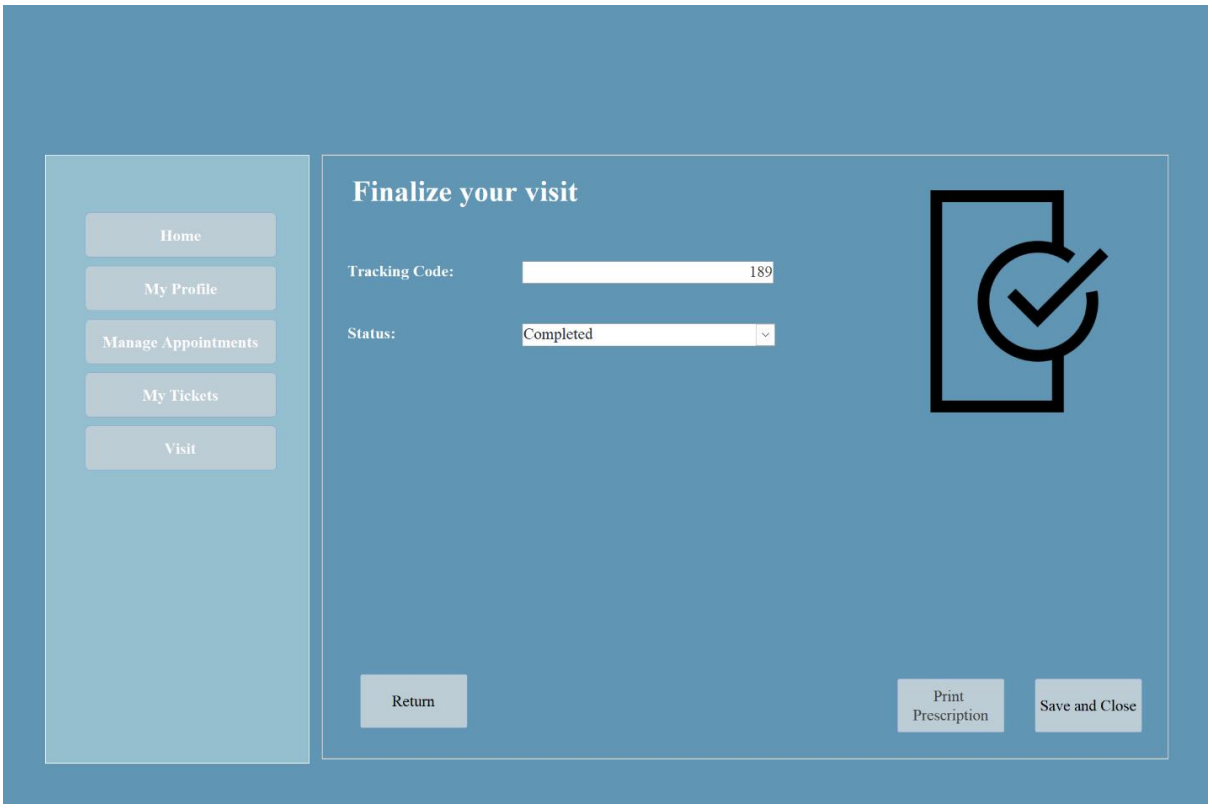


Figure 78: Area for visit finalization

In the final stage, the software assigns a tracking code to the visit, and the practitioner sets its status as "Completed". By selecting this option, the end time of the visit is recorded in the End_Time field of Visit table in Access system. While there are additional options of "Present" and "Cancelled" available in the status combo box, the only permissible choice for the doctor is "Completed". If the doctor attempts to select any other option, a warning message will appear, reminding them that choosing those options is not possible at this stage.

Once the tracking code is generated and the status is determined, if needed the doctor can print the prescription by clicking the "Print Prescription" button and to conclude the visit, they can select the "Save and Close" button.

By clicking on the "Print Prescription" button, the specialized practitioner can generate and print the prescription for the patient. This feature allows for easy and convenient access to the prescription document, enabling the practitioner to provide it to the patient or keep a physical copy for record-keeping purposes.

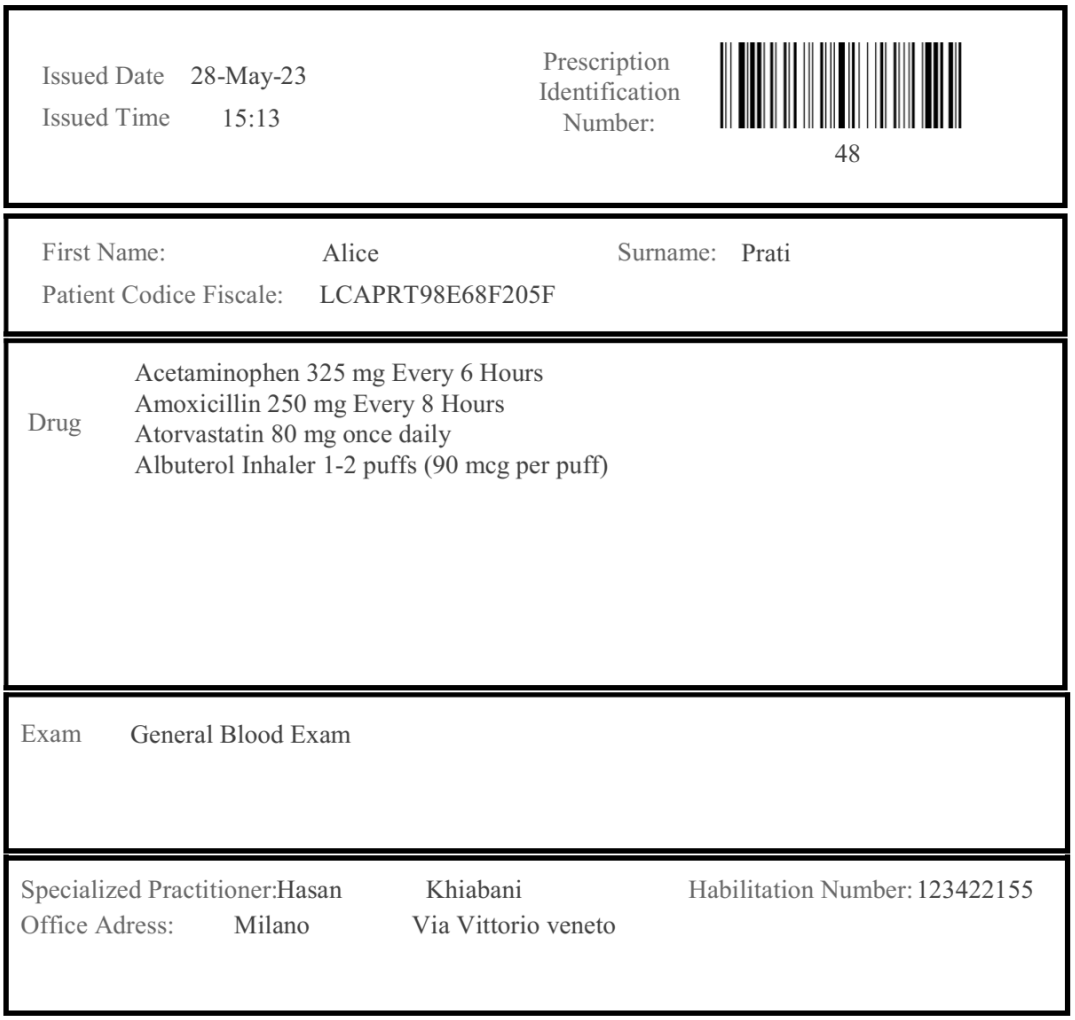


Figure 79: A sample of printable

Annexes

Table 2: List of abbreviations and acronyms

Abbreviation	Definition
BD	Bipolar Disorder
CVD	Cardiovascular Diseases
SMI	Serious Mental Illness
SSRIs	selective serotonin reuptake inhibitors
SNRIs	serotonin-norepinephrine reuptake inhibitors
IPT	Interpersonal therapy
CBT	cognitive-behavioral therapy
MDD	Major depressive disorder
PDD	Persistent depressive disorder
SAD	Seasonal affective disorder
SP	Specialized practitioner
TA	Technical Administrator

References

[1] Y. Kapici, S. Ayhan, B. Guc, and A. TekiN, “Frontal QRS-T Angle and Fragmented QRS in Bipolar Disorder, Do They Differ From The Healthy Subjects?,” *Med. Rec.*, Feb. 2023, doi: 10.37990/medr.1232186.

[2] National Institute of Mental Health, “Depression,” *NIH*. https://www.nimh.nih.gov/health/topics/depression

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