Deliverable D3.2

MATISSE Selected Binaries

MATiSSE

Empower Hospitals' Reliability via TagItSmart Service platform

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Executive Summary

The latest advances in the Internet of Things, cloud computing and analytics have decisively enhanced the automation and rationalization of medical procedures executed in the highly-sensitive hospital environments. Still, unacceptable errors, referred to as never events, occur in these environments having a lower or higher impact on the patients' health, ranging from delivery of wrong drugs to patients, confusion of exams, up to mild or even fatal errors during surgical procedures. MATISSE aims at the elimination of such errors by exploiting the aforementioned technologies.

The role of this document is to provide a brief description of the MATISSE Mobile Application's free version. The main contributions presented in this document include:

- The differences in terms of features between the free version and the full version of the MATISSE Mobile Application
- The connection of the MATISSE Mobile Application to the proposed MATISSE system architecture by clearly defining the architectural components that the application implements
- Descriptions of the steps that should be followed in order for the MATISSE use cases to be executed through the MATISSE Mobile Application

Table of Contents

Executive Summary....4
Table of Contents....5
List of Figures....6
List of Tables....6
List of Abbreviations....7
1. Introduction....8
2. Selected Binaries: MATISSE Mobile Application....9
2.1. The Free Version of the MATISSE Mobile Application....9
2.2. Connection to MATISSE architecture....9
2.3. Development and Integration Technologies....10
2.4. Supported Use Cases....10
2.4.1 Use Case 1: Drugs' Stocktaking....10
2.4.2 Use Case 2: In-Hospital Medication....14
2.4.3 Use Case 3: Smart Medical Exams....15
2.4.4 Use Case 4: Pre-surgery Check....17
2.4.5 Use Case 5: Patients' Monitoring....17
3. Guide for development of MATISSE-style applications....19
3.1. MATISSE-style back-end....19
3.2. MATISSE-style mobile application....20
4. Conclusion....22
References....23

List of Figures

Figure 1: Signing in the MATISSE Mobile Application....12

Figure 2: The main menu of the mobile application (a). The scanner is automatically activated and the Smart Cart's tag is scanned (b)....12

Figure 3: The application has fetched the first patient with his prescriptions' doses....13

Figure 4: The user selects Drug 2 and scans it. It is the correct so the dose is removed from the list....13

Figure 5: The user should have scanned Drug 3 but, mistakenly, scans Drug 5. The application raises a related alert....14

Figure 6: The current patient has no more prescribed drugs, the user selects "NEXT PATIENT" and the next patient is fetched....14

Figure 7: The application fetches the scanned patient and an overview of the cart. It is confirmed the drawer from the app and the drawer with the LED on are the same.....15

Figure 8: The users selectes the drawer from the app's screen and confirms that the bin denoted from the app is the same as the one with the LED on, on the cart....16

Figure 9: The user selects the bin through the app, and the LED on the Smart Cart switches off....16

Figure 10: The patient's tag is scanned (a) and his exam record is visualized (b)....17

Figure 11: The user visualizes specific exams....17

Figure 12: The pending surgery appears and the user visualizes its details....18

Figure 13: The user enters the Patient's Monitoring session and visualizes a list of exams....19

Figure 14: The user visualizes medical history information....19

List of Tables

No table of figures entries found

List of Abbreviations

AM	Access Manager
API	Application Program Interface
APK	Android Package Kit
EC	European Commission
QR	Quick Response
REST	Representational State Transfer
SM	Session Manager
SSc	Smart Tag Scanner
UI	User Interface
WP	Work Package

1. Introduction

The present document, along with the attached Android Package Kit (APK) file, constitute the deliverable of the Work Package (WP) 3 *MATISSE Selected Binaries* of the MATISSE project, reporting the activities conducted in the framework of Task 3.1 “MATISSE software platform development” and Task 3.2 “System Integration and Testing”. The document presents the attached APK file from the following aspects:

- The features of the provided version of the MATISSE Mobile Application
- The connection of the MATISSE Mobile Application to the proposed and implemented MATISSE system architecture [1][2]
- The usage of the application to support each of the defined MATISSE use cases

2. Selected Binaries: MATISSE Mobile Application

The binary that was selected to be provided for public access is the APK file of the free version of the implemented MATISSE Mobile Application. The MATISSE Mobile Application provides access to and allows the execution of the five MATISSE use cases by authorized hospital personnel through Android mobile devices, namely smart phones and tablets.

From a development point of view, the MATISSE Mobile Application consists of five activities; a welcome activity, an activity for login, the main activity in which the user can select one of the five use cases to run, an activity whose contents are dynamic and depend on the use case that is currently executed, and, last but not least, the activity which is responsible for scanning smart tags.

2.1. The Free Version of the MATISSE Mobile Application

Two versions of the MATISSE Mobile Application were implemented and scheduled to be released. In this report the provided free version is briefly presented and accompanied by its APK file. The full version of the MATISSE Mobile Application is analyzed and tested in depth in *D3.3 MATISSE Prototype Testing* [3].

The main difference between the free and full versions concerns the scanning of drugs' packagings during the Drugs' Stocktaking use case. Specifically, in the free version, no smart tag scanning is supported in order to assure that drugs stored under proper storage conditions are selected and placed in the MATISSE Smart Cart. Instead of this, the user is only able to scan the QR code attached to the drug to ensure that it is the correct one.

Of course, the full version of the application ensures not only the placement of correct types of drugs in the MATISSE Smart Cart but also that the delivered drugs have been stored under proper storage conditions.

2.2. Connection to MATISSE architecture

The free version of the MATISSE Mobile Application implements two of the components of the proposed MATISSE architecture. For more information on the MATISSE architecture, the interested reader should refer to deliverable D2.1 [1]. The free version does not implement the Smart Tag scanner component and solely supports the scanning of QR codes.

Access Manager

The Access Manager (AM) is partially implemented by the MATiSSE Mobile Application and provides the user interface (UI) of MATiSSE. In the scope of the MATiSSE Mobile Application, the AM supports authentication and authorization services employing OAuth2.0 and then grants access to its main menu, where, depending on the type of user that is signed-in may or may not allow the execution of a specific use case.

Session Manager

The Session Manager (SM) is fully implemented by the MATiSSE Mobile Application and concerns the smart cart related use cases. Its main responsibilities include initialization, update, and closing of online sessions. The possible duration of a session, though it is defined by the oAuth2.0 provider, is configurable and temporarily set at 10 hours which is considered an adequate time range, covering the case of a nurse working overtime. Of course, as the application handles sensitive medical data, the user must always log out when all of their tasks are completed. Future improvements concerning the SM security might include a lock screen for the mobile device with a unique password or pattern for every user when inactivity of more than 20 seconds occurs.

2.3. Development and Integration Technologies

The MATiSSE Mobile Application is an application targeted for Android devices. It is also mandatory that a camera is available on the device in which the application is executed. The application was developed in Android Studio 3.0.1 [4] with Gradle 4.1 [5]. The minimum SDK version is 19 (Android 4.4 KitKat) and the targeted SDK version is 26 (Android 8.0 Oreo).

Some additional libraries were utilized during the development of our application and are included as dependencies in the Gradle file of our application. These include “com.google.android.gms:play-services-vision:11.6.0” [6] and “de.hdodenhof:circleimageview:2.2.0” [7]. The first offers a vision-related Application Program Interface (API) that is exploited for the implementation of the SSc component of the MATiSSE platform, while the latter, is employed for graphical design purposes.

2.4. Supported Use Cases

The MATISSE Mobile Application provides access to and allows the execution of the five MATISSE use cases by authorized hospital personnel through Android mobile devices, namely smart phones and tablets. The supported use cases of the MATISSE platform and consequently its Mobile Application are as follows:

- Use Case 1: Drugs’ Stocktaking
- Use Case 2: In-Hospital Medication
- Use Case 3: Smart Medical Exams
- Use Case 4: Pre-surgery Check
- Use Case 5: Patients’ Monitoring

In the following subsections steps for the usage of the mobile application for each of the use cases are presented, accompanied by relative figures. It should be noted that the usage of the application is described independently from the other components of the MATISSE platform, for instance the MATISSE Smart Cart.

2.4.1 Use Case 1: Drugs’ Stocktaking

The steps for the execution of the Drugs’ Stocktaking use case are as follows:

1. The user signs in the MATISSE mobile application.
2. The user selects the Drugs’ stocktaking option
3. The scanner is activated; the user scans the cart
4. The first patient appears with a list of medicine to be provided
5. The tester selects a drug from the list in the mobile app, collects the drug (physically) and scans it. If it is wrong, the nurse is notified by the app. If the drug is the correct one it is removed from the list, otherwise, the app waits for another item to be scanned. The process is repeated until the correct drug is collected.
6. The user visualizes the next patient’s medicine list in the mobile app and steps 4-5 are repeated for all patients.
7. When all patients are served, the app returns to the welcome screen and the cart is ready.

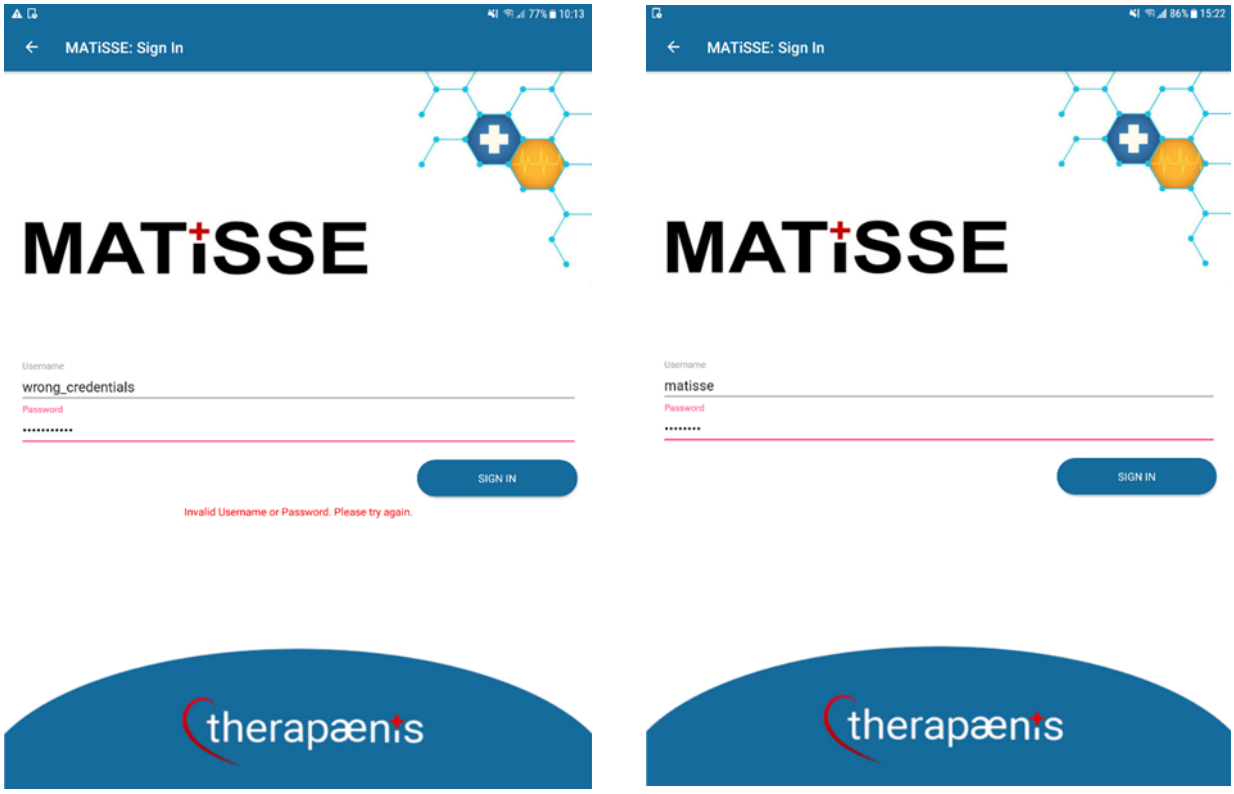
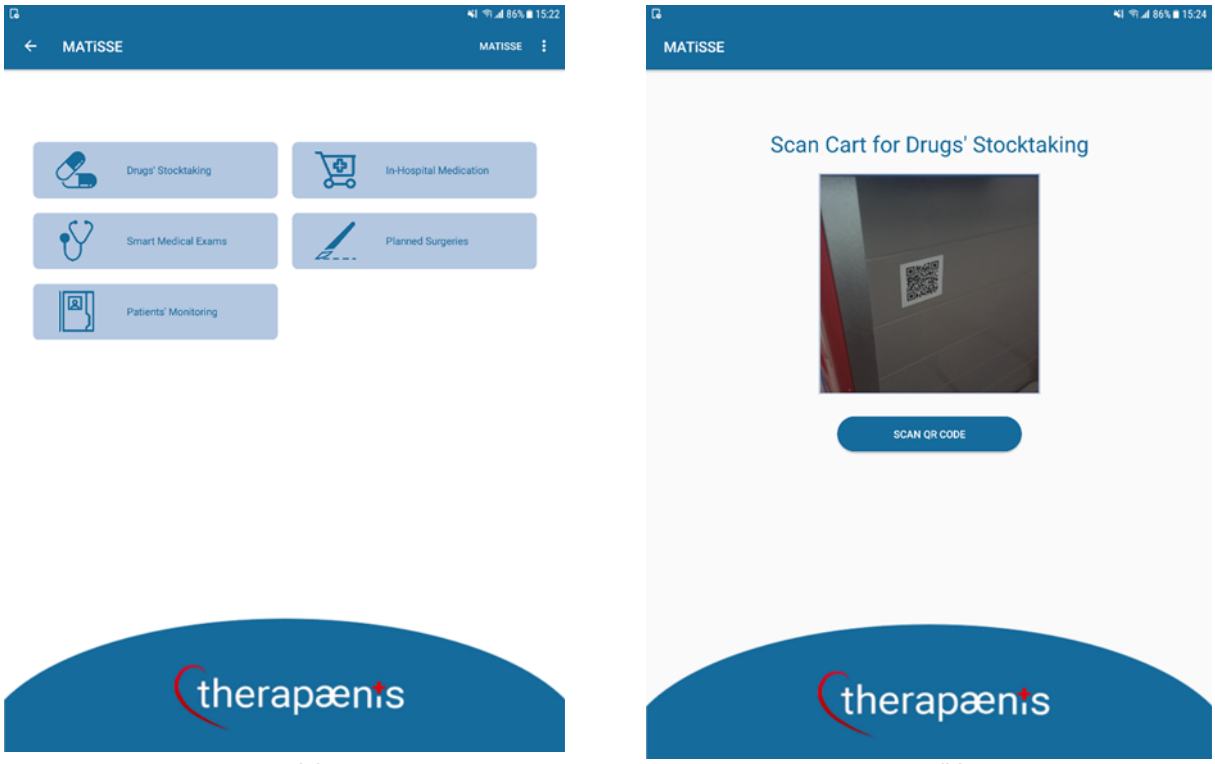


Figure 1: Signing in the MATISSE Mobile Application



(a) *(b)*

Figure 2: The main menu of the mobile application (a). The scanner is automatically activated and the Smart Cart's tag is scanned (b)

Figure 3: The application has fetched the first patient with his prescriptions' doses

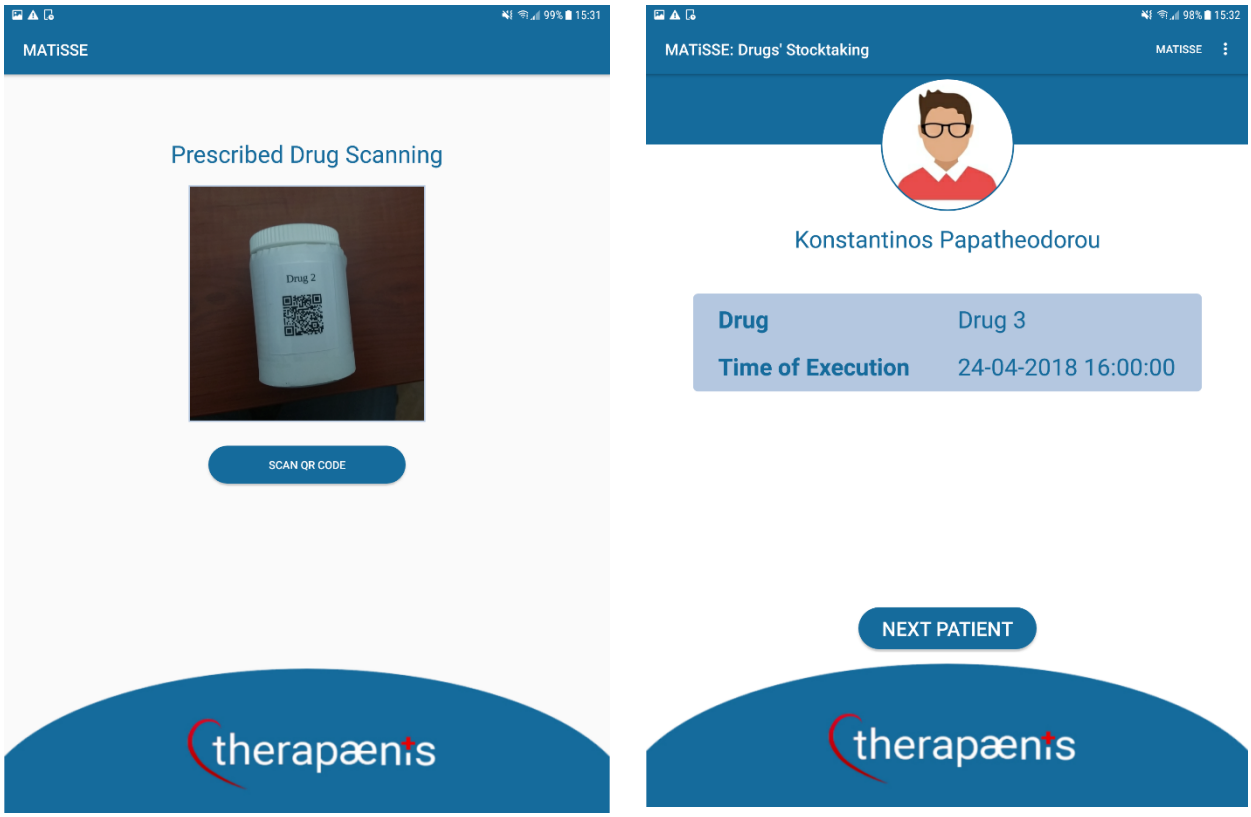


Figure 4: The user selects Drug 2 and scans it. It is the correct so the dose is removed from the list.

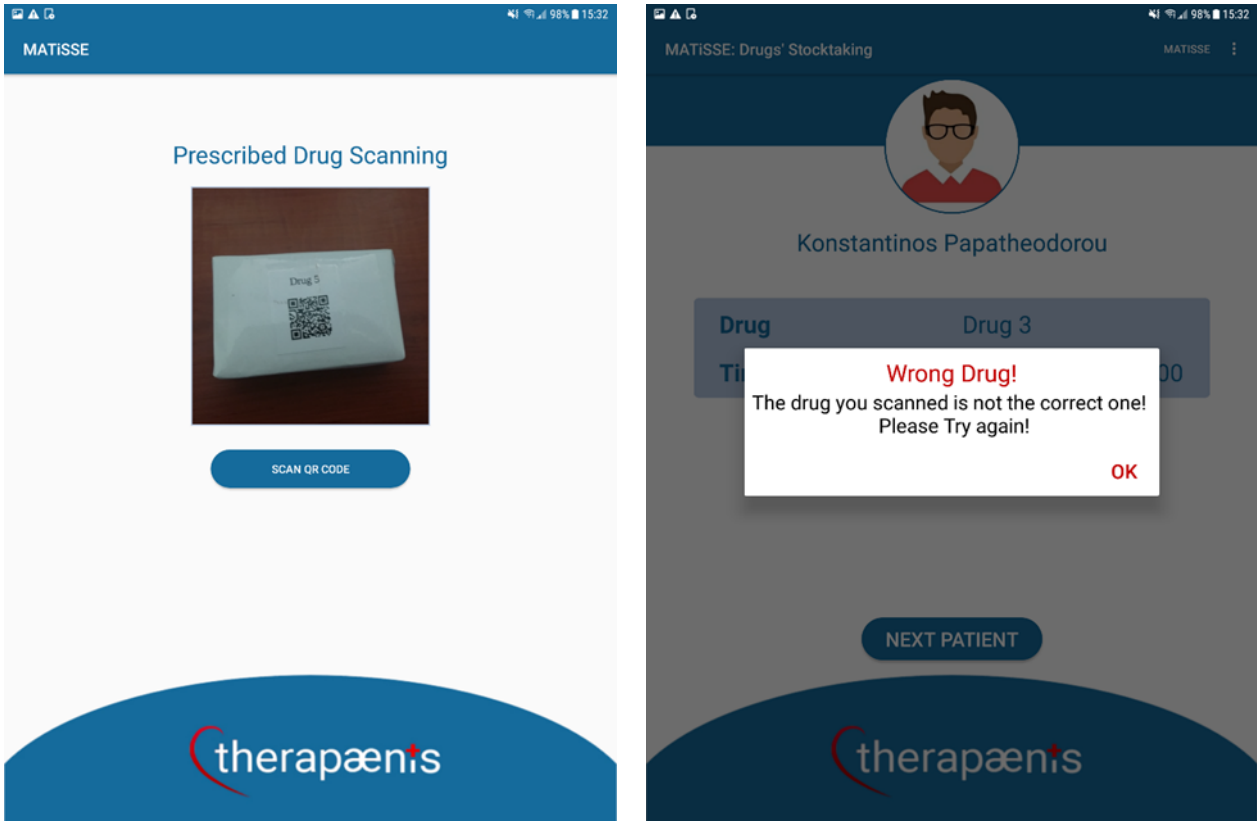


Figure 5: The user should have scanned Drug 3 but, mistakenly, scans Drug 5. The application raises a related alert.

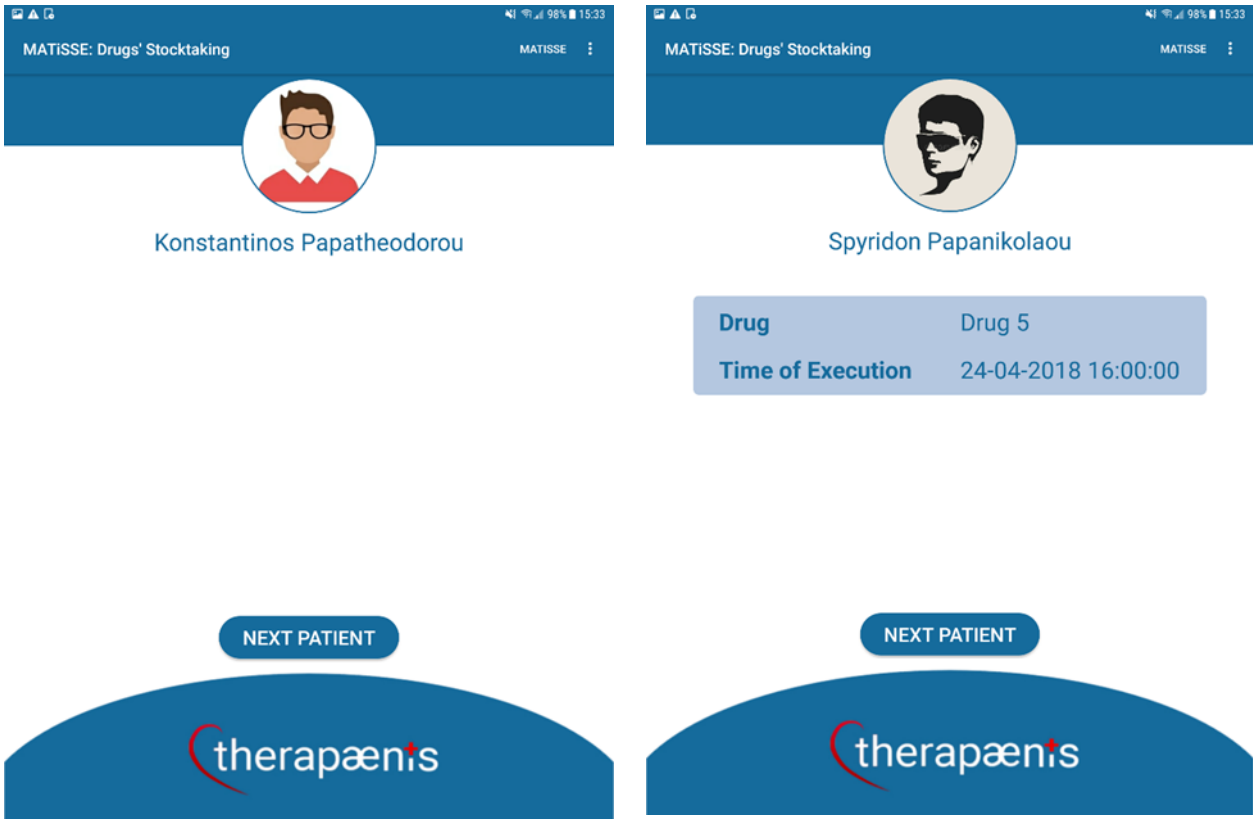


Figure 6: The current patient has no more prescribed drugs, the user selects "NEXT PATIENT" and the next patient is fetched

2.4.2 Use Case 2: In-Hospital Medication

The steps for the execution of the In-Hospital Medication use case are as follows:

1. The user signs in the MATISSE mobile application.
2. The user selects the “In-Hospital Medication” option.
3. The mobile app’s QR scanner is activated and the tester scans the first patient’s tag.
4. The patient’s data appear in the mobile app screen, including the patient’s photo and an overview of the cart’s drawers, indicating the drawer where the current patient’s drugs are stored.
5. The user selects the drawer through the app and the position of the current patient’s bin appears.
6. The user takes the drugs and selects the bin from the app.
7. The user repeats tests 3-6 until all the patients are provided with their medication.

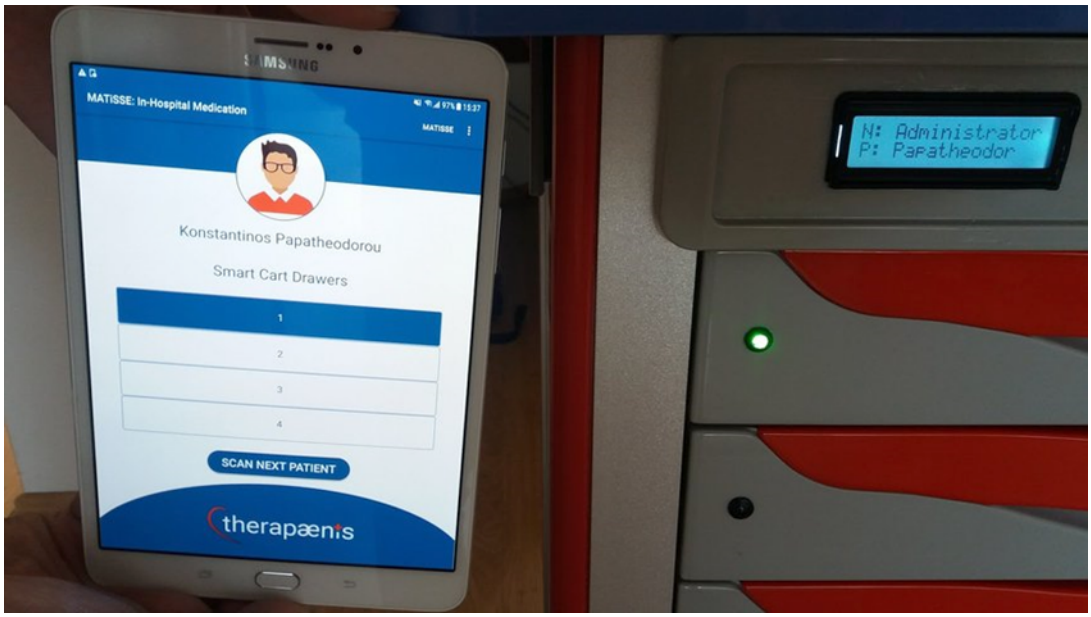


Figure 7: The application fetches the scanned patient and an overview of the cart. It is confirmed the drawer from the app and the drawer with the LED on are the same.

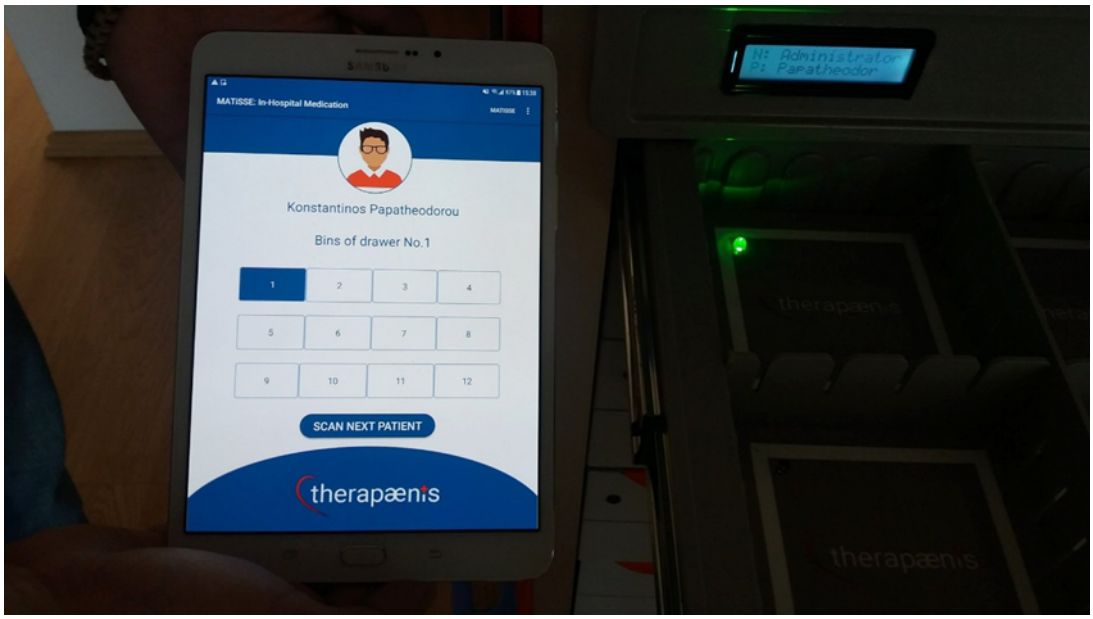


Figure 8: The users selectes the drawer from the app's screen and confirms that the bin denoted from the app is the same as the one with the LED on, on the cart

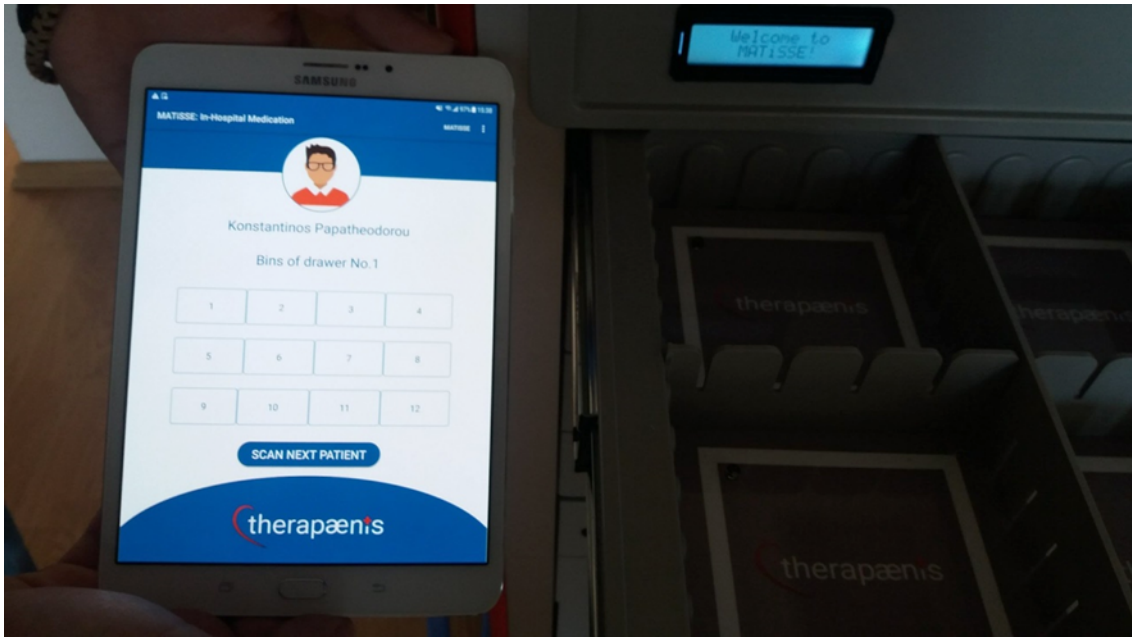
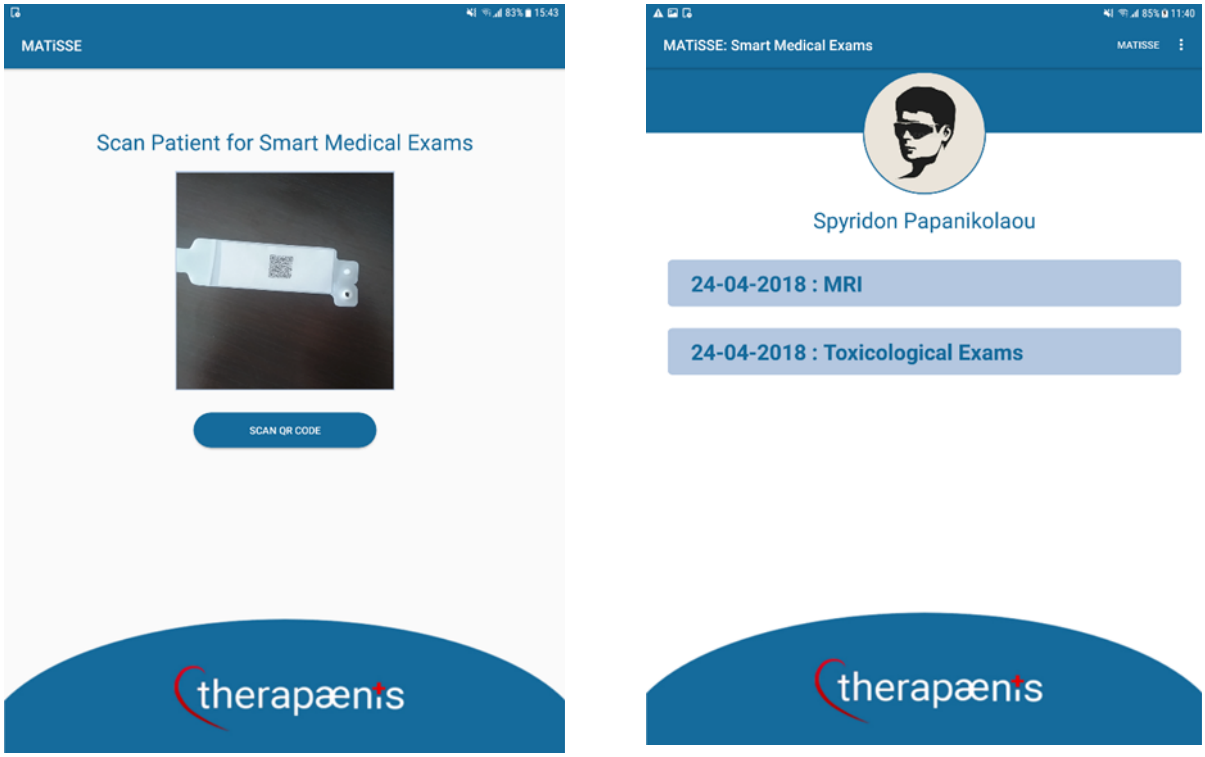


Figure 9: The user selects the bin through the app, and the LED on the Smart Cart switches off

2.4.3 Use Case 3: Smart Medical Exams

The steps for the execution of the Smart Medical Exams use case are as follows:

1. The user signs in the MATISSE Mobile Application.
2. The user selects the Smart Medical Exams option.
3. The mobile app's QR scanner is activated and the user scans the patient's tag.
4. The user visualizes the list of available exams for the scanned patient, if any, through the mobile app.
5. The user selects one medical exam item and visualizes details about it.



(a) (b)

Figure 10: The patient's tag is scanned (a) and his exam record is visualized (b)

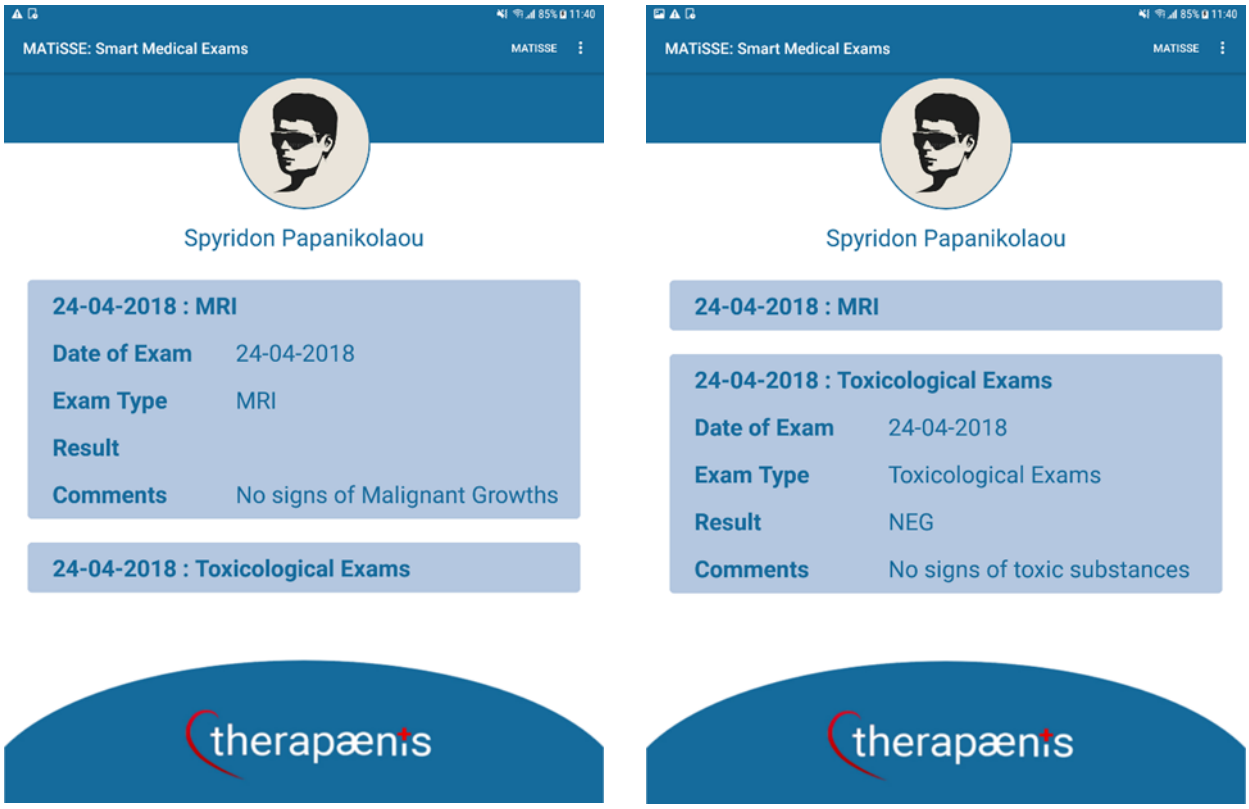


Figure 11: The user visualizes specific exams

2.4.4 Use Case 4: Pre-surgery Check

The steps for the execution of the Pre-surgery Check use case are as follows:

1. The user signs in the MATISSE Mobile Application.
2. The user selects the Planned Surgeries option.
3. The mobile app QR scanner is activated and the user scans the patient's tag.
4. The user visualizes the pending surgery item for the scanned patient, if any, through the mobile app.
5. The user selects the surgery item and visualizes details about it to verify that the correct surgery process is applied to the current patient.

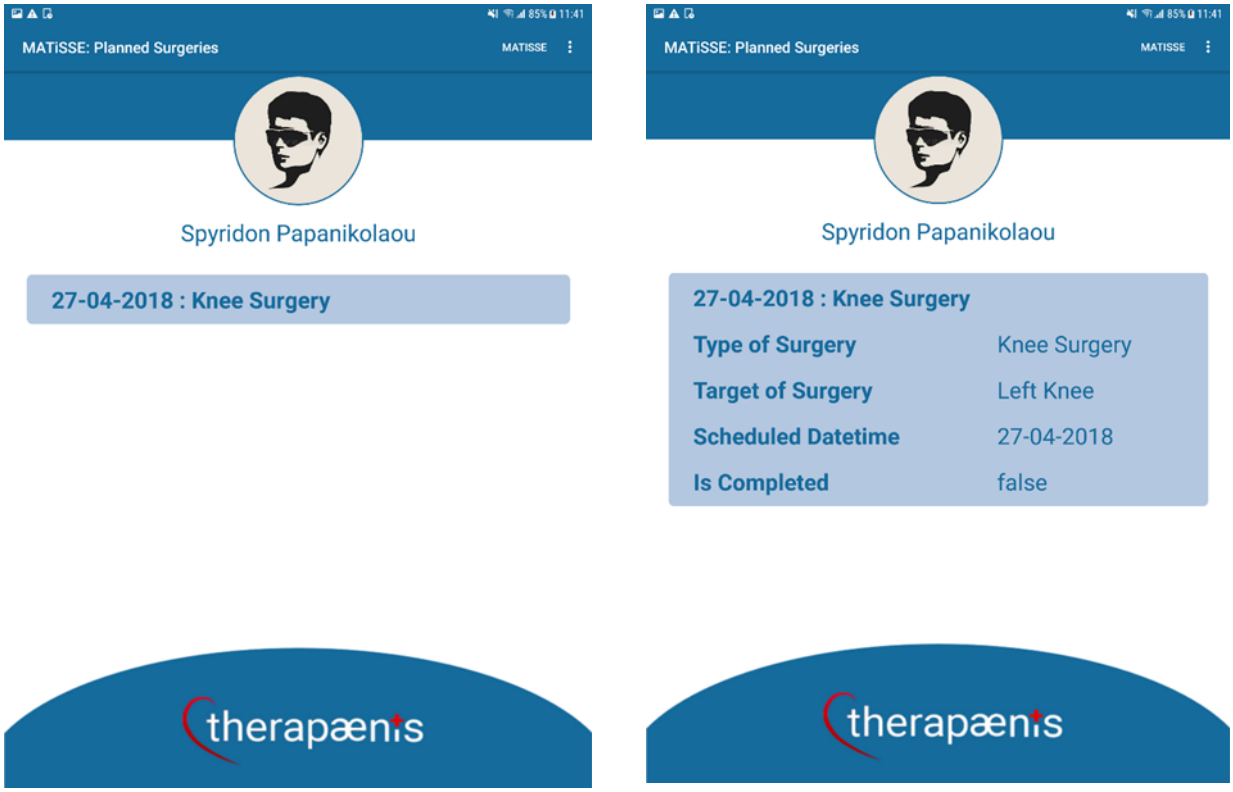


Figure 12: The pending surgery appears and the user visualizes its details

2.4.5 Use Case 5: Patients' Monitoring

The steps for the execution of the Patients' Monitoring use case are as follows:

1. The user signs in the MATISSE mobile application.
2. The user selects the Patients' Monitoring option.
3. The mobile app QR scanner is activated and the user scans the patient's tag.
4. The user visualizes the list of prescriptions, exams, surgeries, hospital admissions or allergies for the scanned patient, if any, through the mobile app.
5. The user selects any item and visualizes details about it to get informed about the current patient's health record.

Figure 13: The user enters the Patient's Monitoring session and visualizes a list of exams

Figure 14: The user visualizes medical history information

3. Guide for development of MATISSE-style applications

This section presents some guidelines intended for any developer who would like to implement a MATISSE-style platform. The guidelines focus on the MATISSE Mobile Application and MATISSE Back-end, as these components communicate directly.

3.1. MATISSE-style back-end

The back-end component of MATISSE is fully implemented as a Representational State Transfer (REST) Application Program Interface (API). The initial step is the definition of the entities along with their relations and associations. Afterwards, the necessities for the execution of each use case must be outlined. In the following, short descriptions of the minimum API that should be implemented for each use case are presented.

Use Case 1: Drugs' Stocktaking

For the Drugs' Stocktaking use case, at least the following operations should be supported by the implemented REST API:

- Associating the patients with pending prescriptions with a specific bin of the smart cart and retrieving them
- Retrieving the pending prescriptions' doses by a patient's ID
- Requesting the smart to indicate the corresponding patient's bin
- Marking the prescriptions' doses as ready (to be distributed to patients)

Use Case 2: In-Hospital Medication

For the In-Hospital Medication use case, the operations that should be carried out include:

- Retrieval of the patient by his/her ID
- Requesting the smart cart to indicate the corresponding patient's bin
- Marking the prescriptions' doses as completed (distributed to patients)

Use Case 3: Smart Medical Exams

For the Smart Medical Exams use case, the minimum API that should be implemented must be able to support:

- Retrieval of a patient and his/her ID
- Retrieval of a patient's exams by his/her ID
- Retrieval of a patient along with the scanned exam by an exam's ID

Use Case 4: Pre-surgery Check

For the Pre-surgery Check use case, the following operations should be supported:

- Retrieval of a patient by his/her ID
- Retrieval of a patient's scheduled surgery by his/her ID

Use Case 5: Patients' Monitoring

For the Patients' Monitoring use case the following operations should be supported:

- Retrieval of a patient by his/her ID
- Retrieval of a patients' hospital admissions by his/her ID
- Retrieval of a patients' past and active prescriptions by his/her ID
- Retrieval of a patients' exams by his/her ID
- Retrieval of a patients' completed and scheduled surgeries by his/her ID
- Retrieval of a patients' allergies by his/her ID

3.2. MATISSE-style mobile application

Besides the Graphical User Interface (GUI) that the MATISSE Mobile Application offers, from a structural aspect the application consists of five activities:

- Welcome Activity
- Login Activity
- Main Activity
- Scanner Activity
- Session Activity

Descriptions on each of the activities, along with guidelines for development are presented in the following.

Welcome Activity

The Welcome Activity of the MATISSE Mobile Application gives an overview of the use cases that are offered by MATISSE in the form of slides. The user can skip the activity immediately or press the button to see the next slide. When reaching the last slide, a launch button appears and the user moves to the login activity.

Login Activity

The login activity is a significant one from an aspect of security. It includes a login form where the user fills in his/hers username and password. The essential requests are made to the MATISSE-style back-end component and a token is received. After the user has signed in, the Main Activity makes its appearance.

Main Activity

The main activity is the main menu of the mobile application. The user can select and execute any of the available use cases. Additionally he/she may choose to change the display language, logout from the application or remotely shutdown the smart cart component. When the user selects any of the aforementioned use cases the Scanner Activity is triggered.

Scanner Activity

Depending on the use case that was selected in the previous activity, the scanner activity will initially urge the user to either scan the smart cart's tag or a patient's tag. For the scanner itself, the developer might use one of the existing open source QR and barcode scanners or exploit the Mobile Vision API offered by Android and develop his/her own scanner. When the scanning succeeds the appropriate requested content is displayed through the session activity.

Session Activity

Most of the content that is visualized in the Session Activity is dynamic and depends on the use case that is executed. In every use case, a patient is visualized on the top of the mobile app screen. The rest of the content differs, depending on the use case that is executed:

- **Use case 1: Drugs' Stocktaking.** In this use case, the content includes the list of prescription doses that should be received by the patient and a "Next Patient" button.
- **Use case 2: In-Hospital Medication.** In this use case, the content includes a front view of the cart drawers and an overview of the drawer's bins to indicate the corresponding patient's bin.
- **Use case 3: Smart Medical Exams.** In this use case, the content includes the list of exams for the scanned patient or the specific scanned exam.
- **Use case 4: Pre-surgery Check.** In this use case, the content includes the scheduled surgery of this patient.
- **Use case 5: Patients' Monitoring.** In this use case, the content includes five categories of data, namely, admissions, prescriptions, exams, surgeries and allergies.

4. Conclusion

The current report provides a brief description of the selected binaries provided for public access. The chosen binary was the APK file of the free version of the MATISSE Mobile Application. The main difference between the free and full versions of the mobile application focuses on whether the scanning of the drugs' packagings during the Drugs' Stocktaking use case is supported.

The MATISSE Mobile Application implements three of the components in the proposed MATISSE system architecture, the Access Manager, the Session Manager and most importantly the Smart Tag Scanner, which in the provided version solely supports the scanning of QR codes.

The implemented and supported by the application use cases are the ones also described in previous deliverables and include drugs' stocktaking, in-hospital medication, smart medical exams, pre-surgery check and patients' monitoring. A series of steps are provided as instructions for the execution of the aforementioned use cases.

The MATISSE Mobile Application has been tested extensively in laboratory environment, as part of the implemented MATISSE platform which includes the MATISSE Back-end, the MATISSE Dashboard and the MATISSE Smart Cart. The results of the testing process are included in the report D3.3 "MATISSE prototype testing evaluation", while the actual validation of the MATISSE prototype in real hospital environment will be included in D4.2 "MATISSE pilot validation".

References

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