TALLINN UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF SOFTWARE SCIENCE

Procurement Of Health Information System For 25 Primary Health Centers In Nigeria

Lab 3 in subject "Software Quality and Standards" (IDY0204)

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7. Functional Specification-Based Testing

7.1. The component and its requirements

The "appointment module" is chosen for functional testing, and its requirements are drafted in the same way as in lab 1 but with some adjustments. The appointment module was selected due to extensive knowledge of the module gained from previous lab activities.

Use Case ID	FR-004
Use Case Name	Creating new appointment
Primary Actor	Doctor
Criteria	1. The patient record exists in the database 2. The doctor can only create appointments for upcoming dates 3. The doctor can use only free slots in the calender to make an appointment 4. During appointment creation, the doctor cannot set an appointment end time that is before the appointment start time 5. The meeting shall be limited to one working day 6. The doctor picks type of appointment from existing types in the system

Use Case ID	FR-005
Use Case Name	Modify appointment
Primary Actor	Doctor
Preconditions	Appointment exists in the HIS
Postconditions	The appointment is changed
Main Success Scenario	1. The doctor finds the appointment that needs to be changed. 2. The doctor modifies the appointment. The requirements for changing an appointment are the same as those for making a new one.

Use Case ID	FR-006
Use Case Name	Cancel appointment
Primary Actor	Doctor
Preconditions	Appointment exists in the HIS
Postconditions	The appointment is deleted from the HIS
Main Success Scenario	1. The doctor finds the appointment that they want to delete. 2. The doctor deletes the appointment and confirms deletion.

7.2. Functional tests design

To design our functional tests, we have outlined what our equivalence classes are based on our system's requirements, and have chosen test data that correspond to the classes. An outline of design activities can be found in our functional tests design spreadsheet. This document contains the equivalence classes, test data and twenty (20) derived functional tests.

7.3. Tests execution and results

The team chose to manually test the tests formulated for the system in 7.2. because the open source system we chose did not have automated testing built in. It would have been extremely difficult to set up tests for the appointment module in isolation because it relied on other modules. Having said that, we've included the results of the manual testing below.

Use Case ID	Test Description	Steps to reproduce	Acceptance Criteria	Status
UC-002	Show "error" that Start Time must be before End Time in create appointment	1. Go to new appointment page 2. Fill in all empty fields with test data provided in test design 3. Click "Schedule Appointment"	Show text "Start Time must be before End Time"	Passed

UC-003	Show "success" that appointment is booked successfully in create appointment	1. Go to new appointment page 2. Fill in all empty fields with test data provided in test design 3. Click "Schedule Appointment"	Show text "Successfully created appointment"	Passed
UC-012	Show "error" that Start Time must be before End Time in modify appointment	1. Go to new appointment page 2. Fill in all empty fields with test data provided in test design 3. Click "Schedule Appointment"	Show text "Start Time must be before End Time"	Passed
UC-016	Show "success" that appointment is modified successfully	1. Once the appointment is created 2. Go to Appointment Schedule 3. Select the appointment to modify from the calendar 4. Click on "Edit" 5. Change the "Type" to "Emergency" 6. Click on "Update Appointment"	Show text "Successfully updated appointment"	Passed
UC-020	Show "success" that Appointment is deleted successfully	1. Once the appointment is created 2. Go to Appointment Schedule 3. Select the appointment to delete from the calendar 4. Click on red "Delete Appointment button" 5. Click on "Delete" for delete confirmation	Show text "Successfully deleted appointment"	Passed

Test incident report ID	TIR1
Test ID, date, tester	UC-001, 11/14/2021, Monika Shrestha
Summary	When creating new appointment, start date should not be in the past
Inputs	Test data provided in test design
Expected results	Error with message that says "Start date should not be in the past"
Actual results	Success with message that says "Successfully created appointment"

Test incident report ID	TIR2
Test ID, date, tester	UC-004, 11/14/2021, Monika Shrestha
Summary	When creating new appointment, meeting should not exceed more than 24 hours
Inputs	Test data provided in test design
Expected results	Error with message that says "Meeting should be limited to 24 hours"
Actual results	Success with message that says "Successfully created appointment"

Test incident report ID	TIR3
Test ID, date, tester	UC-005, 11/14/2021, Monika Shrestha
Summary	When creating a new appointment, slots should be available
Inputs	Test data provided in test design
Expected results	Error with message that says "Slot is not available"
Actual results	The system has a different flow for this

Test incident report ID	TIR4
Test ID, date, tester	UC-006, 11/14/2021, Monika Shrestha
Summary	When creating an appointment, patient name should exist
Inputs	Test data provided in test design
Expected results	Error with message that says "Patient name doesn't exist"
Actual results	Error with message that says "Patient is required"

Test incident report ID	TIR5
Test ID, date, tester	UC-007, 11/14/2021, Monika Shrestha
Summary	When creating a new appointment, appointment type should exist
Inputs	Test data provided in test design
Expected results	Error with message that says "Appointment type does not exist"
Actual results	Not possible to test from the UI because system only provides a select dropdown with preloaded appointments

Test incident report ID	TIR6
Test ID, date, tester	UC-008, 11/14/2021, Monika Shrestha
Summary	When creating a new appointment, start and end dates should not be the same
Inputs	Test data provided in test design
Expected results	Error with message that says "Start and end dates cannot be the same"
Actual results	Success with message that says "Successfully created appointment"

Test incident report ID	TIR7
Test ID, date, tester	UC-009, 11/14/2021, Monika Shrestha

Summary	When modifying an appointment, start and end dates should not be the same
Inputs	Test data provided in test design
Expected results	Error with message that says "Start and end dates cannot be the same"
Actual results	Success with message that says "Successfully updated appointment"

Test incident report ID	TIR8
Test ID, date, tester	UC-010, 11/14/2021, Monika Shrestha
Summary	When modifying an appointment, patient name should exist
Inputs	Test data provided in test design
Expected results	Error with message that says "Patient name doesn't exist"
Actual results	The system does not currently allow for a patient's name to be updated.

Test incident report ID	TIR9
Test ID, date, tester	UC-011, 11/14/2021, Monika Shrestha
Summary	When modifying an appointment, start date should not be in the past
Inputs	Test data provided in test design
Expected results	Error with message that says "Start date should not be in the past"
Actual results	Success with message that says "Successfully updated appointment"

Test incident report ID	TIR10
Test ID, date, tester	UC-013, 11/14/2021, Monika Shrestha
Summary	When modifying an appointment, meeting should not exceed

	more than 24 hours
Inputs	Test data provided in test design
Expected results	Error with message that says "Meeting should be limited to 24 hours"
Actual results	Success with message that says "Successfully updated appointment"

Test incident report ID	TIR11
Test ID, date, tester	UC-014, 11/14/2021, Monika Shrestha
Summary	When modifying an appointment, appointment type should exist
Inputs	Test data provided in test design
Expected results	Error with message that says "Appointment type does not exist"
Actual results	Not possible to test from the UI because system only provides a select dropdown with preloaded appointments

Test incident report ID	TIR12
Test ID, date, tester	UC-015, 11/14/2021, Monika Shrestha
Summary	When modifying an appointment, slots should be available
Inputs	Test data provided in test design
Expected results	Error with message that says "Slot is not available"
Actual results	Success with message that says "Successfully updated appointment"

Test incident report ID	TIR13
Test ID, date, tester	UC-017, 11/14/2021, Monika Shrestha
Summary	When modifying an appointment, appointment shouldn't be in pending
Inputs	Test data provided in test design

Expected results	Error with message that says "Pending appointment cannot be modified"
Actual results	Not possible to test because the system doesn't display pending appointments

Test incident report ID	TIR14
Test ID, date, tester	UC-018, 11/14/2021, Monika Shrestha
Summary	When modifying an appointment, appointment should exist
Inputs	Test data provided in test design
Expected results	Error with message that says "Appointment does not exist"
Actual results	Not possible to test from the UI because the system only displays existing appointments on the calendar view. You cannot access the modify page if the appointment does not show up

Test incident report ID	TIR15
Test ID, date, tester	UC-019, 11/14/2021, Monika Shrestha
Summary	When deleting an appointment, appointment should exist
Inputs	Test data provided in test design
Expected results	Error with message that says "Appointment does not exist"
Actual results	Not possible to test from the UI because the system only displays existing appointments on the calendar view. You cannot access the delete button if the appointment does not show up

8. Risk assessment and designing acceptance tests

8.1. Risk assessment

In this section, the main risks outlined in lab 1 are discussed and ranked based on their potential impact and frequency, using the 5X5 risk matrix. Each risk is assigned an identifier that allows it to be referred to. The likelihood of incident, risk assessment matrix and main risks are described as follows:

8.1.1 Likelihood of Incident

Very Low	Very unlikely to happen
Low	Once every 182 days
Medium	Once every 30 days
High	Once 7 days
Very High	Once an hour

8.1.2 Risk assessment matrix

The matrix's levels are Very Low, Low, Medium, High, and Very High. To have a low level of risk, we must have a relatively low likelihood and severity. It is important to note that a hazard with a very low business impact is normally low risk, but it might become medium risk if it occurs frequently.

		Likelihood of Incidence				
		Very Low	Low	Medium	High	Very High
Impact	Very Low	1	2	3	4	5
	Low	2	3	4	5	6
	Medium	3	4	5	6	7
	High	4	5	6	7	8
	Very High	5	6	7	8	9

8.1.3 Assessment of system usage risks

After reassessing the main risks outlined in lab 1 - section 3.3, we discovered that many of them also refer to the physical environment in which the system is deployed. Because we have little control over those risks, we have simply discussed the dangers associated with system usage. They are listed and described in the following order:

Risk ID	Description	Likelihood	Impact	Risk Rating	Priority
R1	HIS is down or not responding	Very Low	Very High	5	2
R2	Unauthorised person log in to the system	Low	Very High	6	1
R3	HIS functionality is unstable and is inconsistent	Low	Very High	6	1
R4	Incomprehensible graphical user Interface	Low	Medium	4	3
R5	Data security	Medium	High	6	1

8.2. Risk-based acceptance tests

From the previously defined risks and requirements, twenty (20) risk-based acceptance tests are outlined below in the order of risk priority. Twelve of these tests focus on functional requirements. The other eight requirements focus on non-functional requirements (with two of them being load tests).

Test ID	Risk ID	Req ID	Input Description	Expected Output Description
T1	R2	NFR-001	A user tries to log in with invalid credentials	The system denies user access
T2	R2	FR-007	An authorized user who is not a doctor tries to prescribe a patient	The system displays an error
T3	R3	FR-001	The user fills in the correct input fields for creating a new patient	The system successfully adds a patient, with message "Patient successfully created"

T4	R3	FR-002	The user fills in the information that is to be updated	The system successfully updates patient's information, with message "Patient successfully updated"
T5	R3	FR-003	The user enters an existing patient's name or ID	A list of patients is displayed
T6	R3	FR-003	The user enters a name or ID of a patient that does not exist	The system displays a message that says "Patient does not exist"
T7	R3	FR-007	The user fills in necessary information for prescribing medication	The system successfully adds a prescription to the user
T8	R3	FR-008	The user fills in necessary information for modifying medication	The system successfully modifies a user's prescription
T9	R3	FR-009	The user passes in a prescription ID to be cancels	The system successfully cancels a user's prescription by updating prescription status
T10	R3	FR-010	The user opens the calendar view for appointments	The system shows an overview of all appointments in the system.
T11	R5	NFR-002	DROP TABLE patients	The system has backup of patients and is able to restore data
T12	R1	NFR-006, NFR-009	The user enters new information into the system	The system responds with message within 1 second
T13	R1	NFR-006, NFR-009	The user performs a search using patient name or ID	The system provides search results in 5-7 seconds due to the system's utilization of offline databases
T14	R1	NFR-007 (load)	50 Doctors add new patient at the same time	The system does not crash
T15	R1	NFR-007 (load)	100 users log in at the same time	The system does not become slow
T16	R1	NFR-009	The user opens the application on all major browsers including Chrome and Firefox	The system is available on all aforementioned browsers

T17	R4	FR-007	A user tries to prescribe a drug not present in the system	The system prompts the user with available medication within the system
T18	R4	NFR-003	The system opens the application in different countries and time zones	All of the system's display is in the supported language - In this case, english.
T19	R4	FR-006	A user attempts to cancel an appointment	The system prompts the user to confirm action
T20	R4	FR-001, FR-002, FR-007, FR-008, FR-012	The user attempts to fill any form without the required fields	The system notifies the user of missing fields

8.3. Acceptance Criteria

The fundamental acceptance criterion is that the system is used for its intended purpose and that it meets all requirements. That being said, acceptance of the software is based on the acceptance tests stated above. All tests that assess whether critically significant requirements are met must be passed. For the software to be accepted, 90 percent of all other tests must pass. As described in Lab 01, the table below summarizes acceptance of key aspects of the system development, testing and maintenance phase:

Action	Deliverable	Time
Requirements definition: Functional and Non-Functional requirements are defined.	The documentation provided by the procurer	Performed before procurement. The detailed requirements shall be specified in the following stages
Development (optional) Developers shall select HIS that meets the maximum requirements of the procurer. In case not all requirements to HIS are satisfied, the developers team shall develop missing functionality and make changes in accordance to the procurer's requirements	Source code and documentation for HIS that meets procurer's requirements	(optional) Two months

Testing the system performance: 1. Installation of HIS to 50 other health centers 2. Testing HIS in the health center environment performed by the development team	Report and demonstration provided by the development team to the procurer	One month
Maintenance The development team will be responsible for maintenance. The development team must ensure that the HIS operates properly during maintenance. Additionally, they must delete obsolete files from storage and guarantee sufficient backup security.	Maintenance report provided by the development team to the procurer.	Post-contractual requirements to perform quarterly maintenance. The project's budget covers maintenance for a year.

9. Preliminary evaluation based on acceptance tests

9.1. Functional acceptance testing

The results of all 12 functional acceptance tests specified above have been manually tested, and are given in the tables below:

Test ID	Test Description	Steps to reproduce	Acceptance Criteria	Status
T3	Show "success" when the user fills in the correct input fields for creating a new patient	1. Go to New Patient Page 2. Fill in all the fields with correct information 3. Click on save	Show text "Successfully created patient"	success
T4	Show "success" when the user updates the information of a patient	1. Go to Patient List 2. Click on View 3. Click on Edit 4. Fill in the fields you would like to update 5. Click on update patient	Show text "Successfully updated patient"	success
T5	Display a list of patients when the user enters an existing patient's name or ID	1. Go to New Patient Page 2. Fill in all the fields with correct information 3. Click on save 4. Go to Patient List 5. Search for the patient you have just created	Display a table with the patient with the name or ID	success
T7	Success when the user fills in necessary information for prescribing medication	1. Go to the Add Medication Page 2. Type in the name of a patient you have created previously 3. Fill in all the necessary information 4. Click on Request Medication	Show the user the newly prescribed medication	success
T8	Success when the user fills in necessary information for modifying medication	1. Go to the Medication Request Page 2. Click on View 3. Change some value like quantity 4. Click on update	Show the medication table with data updated correctly	success

		Medication		
T9	Success when the user cancels an existing prescription	1. Go to the Medication Request Page 2. Search for the medication you want to delete if there are several 2. Click on View 3. Click on Cancel Medication	Medication status updates to cancelled	success
T10	Show appointment calendar with overview of existing appointments	1. Go to new appointment page 2. Select the patient 3. Specify the start and End date 4. Click on 'Schedule Appointment'' 5. Go to the Appointment schedule	Show booked slot for the appointment that was created	Success
T19	Prompt when a user attempts to delete appointment	1. Go to the Appointment schedule 2. Select the appointment that you want to delete from the calendar 3. Click on red "Delete Appointment button"	Confirmation Prompt shows up	success
T20	Show "errors" when the user attempts to fill any form without the required fields	1. Go to New Patient Page 2. Fill all fields except the required field 3. Click on create patient	Show "Could not create new patient"	success

Test incident report ID	TIR16
Test ID, date, tester	T2, 11/15/2021, Monika Shrestha
Summary	An authorized user who is not a doctor tries to prescribe a patient
Inputs	The user fills the necessary information in the form
Expected results	Error with message that says "Access not granted"
Actual results	Authentication and Authorization functionality does not exist
Severity	High

Test incident report ID	TIR17
Test ID, date, tester	T6, 11/15/2021, Monika Shrestha
Summary	The user enters a name or ID of a patient that does not exist
Inputs	Any string that does not exist in database
Expected results	Error with message that says "Patient name doesn't exist"
Actual results	Displays an empty table with no patients
Severity	High

Test incident report ID	TIR18
Test ID, date, tester	T17, 11/15/2021, Monika Shrestha
Summary	A user tries to prescribe a drug not present in the system
Inputs	A string representing drug that should not exist in the database
Expected results	Error with message that says "Drugs doesn't exist in the system"
Actual results	The system does not provide functionality for existing drugs.
Severity	Medium

9.2. Non-functional acceptance testing

Our non-functional requirements testing is divided into three groups based on their purpose. The manual tests are summarized in the first part. The tests in this section are manual and focus on system functionality.

The load test is the second section. This section focuses on T14 and T15. The idea is to test the strain of multiple users accessing the software concurrently based on expected usage. The final component is concerned with GUI performance. This section is significant since one of the most important considerations for the system is that it be reliable offline due to how critical its usage is.

9.2.1 Manual Tests

Test ID	Test Description	Steps to reproduce	Acceptance Criteria	Status
T16	Success when a user opens HIS on all major browsers	1. Run the Hospital Run link in Chrome and in Firefox browser	The dashboard should be displayed	success
T18	Default language is english	1. Change the time zones of your PC to different time zones 2. Run the Hospital Run link in your browser	The dashboard should have text displayed in english	success

Test incident report ID	TIR19
Test ID, date, tester	T1, 11/15/2021, Monika Shrestha
Summary	A user tries to log in with invalid credentials
Inputs	Fill in credentials in a login page
Expected results	Error with message that says "Invalid credentials"
Actual results	Authentication functionality does not exist in the system
Severity	Very High

9.2.2 Load Tests

The software offered for testing is a progressive web app that stores data in an indexed database (browser DB). This is due to the fact that its core feature is Offline-first. However, because there is no central remote database, several users cannot access the same system at the same time. Each user has their own copy.

The system's utilization purpose is to connect it to some kind of local network in a hospital or geographical area. As a result, determining performance indicators for tests T14 and T15 has become impossible.

9.2.3 GUI Performance Tests

To test UI response time, we would need JMeter with selenium setup. Unfortunately, we do not have access to the software to test this out. Therefore, we put an outline in the incidence report tables below:

Test incident report ID	TIR20
Test ID, date, tester	T11, 11/20/2021, Monika Shrestha
Summary	DROP TABLE patients
Inputs	A system should have table with patients
Expected results	The system has backup of patients and restore data
Actual results	No access to database functionality
Severity	High

Test incident report ID	TIR21
Test ID, date, tester	T12, 11/20/2021, Monika Shrestha
Summary	The user enters new information into the system
Inputs	The user tries to create new patient
Expected results	The system responds with message within 1 second
Actual results	Not possible to test
Severity	Low

Test incident report ID	TIR22
Test ID, date, tester	T13, 11/20/2021, Monika Shrestha
Summary	The user performs a search using patient name or ID
Inputs	Patient name or ID
Expected results	The system provides search results in 5-7 seconds due to the system's utilization of offline databases
Actual results	Not possible to test

Severity	Low

9.3. Summarising the results of acceptance testing

As seen in the summary for functional requirements testing, 75% of the tests pass. The tests cover around 75% of the criteria. We purposely left out the appointment module requirements because they are thoroughly discussed in section 7.2. We were unable to test several of the non-functional requirements due to the nature of the system involved. Having said that, we can observe that 25% of the tests pass, 50% were not testable for the reasons outlined, and the remaining 25% fail.

The tests were not comprehensive enough to thoroughly assess all of the system's functionality. Also, there were limitations to the requirements we had defined and the actual functionality of the system.

9.4. System evaluation, risk analysis, acceptance

Given all of the previous results and the acceptance criteria, it is concluded that the system is not ready for use at this time. It is clear that the system does not meet established requirements out of the box and would require significant development to be useful. The acceptance criteria defined above remain in effect