TALLINN UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF SOFTWARE SCIENCE

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

Lab 1 in subject "Software Quality and standards" (IDY0204)

Authors, student group:

Olga Vovk
Monika Shrestha
Kehinde Esther Ogundeyi
Chioma Jessica Nkem-Eze

Team ID: Digital Health
Supervisor: Jaak Tepandi
Presented: 25th Sept 2021

TALLINN 2021

Table of Content

1. Project Description

1.1. Introducing The Organisation

The African Development Bank Group (ADBG) is a not-for-profit organization dedicated to social advancement in its regional member countries (RMCs). Nigeria is a member of the RMC. As part of project NHPC-IV, the ADBG aims to procure a Hospital Information System (HIS) for twenty-five primary health centers across several villages in Northern Nigeria. The acquisition is part of Nigeria's strategy for e-Health development, which aims to expand access to healthcare and digitize patients' electronic health records.

These primary health centers are located in villages to improve health outcomes for residents of rural areas who lack access to some of the larger clinics in the cities. Typically, each of these health clinics has two to three health care professionals (i.e. doctors) who diagnose and treat patients. The initiative is supported to achieve UNICEF's Sustainable Development Goals, notably "3. Promote health and well-being" (https://www.unicef.org/sdgs).

1.1.1. Goals And Value Of The System For The Organisation

All this time, primary health clinics have had to manage patient data manually for each community they serve. Manual patient record management is damaging to Nigeria's e-health development plans, as there is no data to guide health policies that would address evident rural community needs. As a result, the HIS is essential to assist these centers in digitizing patient records. The procurement covers both the HIS system and the installation and configuration of necessary infrastructure. The ADBG first funded the project by providing computer systems to each of the 25 health clinics.

1.1.2. System Properties That Are Critical For The Organisation

Properties	Justification
The HIS will offer patient management functionality.	The digitization of health records is a positive step forward in a country's advancement.
Offline usage will be possible.	Internet connections in these rural areas are very weak or non-existent. The system must stay available at all times.
User Role: Doctor	The user must be authenticated as a "doctor" in order to have access to the system.

Appointment scheduling	To efficiently manage patients that require follow-up, the doctor should have the ability to schedule, change, or cancel a patient's appointment in the HIS.
Prescription management	Prescriptions are a critical component of the post-diagnosis treatment procedure. The doctor should be able to manage a patient's prescriptions in the HIS.

1.1.3. Stakeholders And Their Expectations

Stakeholder	Expectation
Procurer: African development bank group	The HIS is delivered to the health centers, and the necessary infrastructure is established.
Primary health centers	- Primary health centers are a recipient. - HIS is installed in the health center and meets the stipulated requirements. - HIS includes sufficient documentation to assist the end-users. - Doctors receive training on how to operate the system.
Development team	- Install HIS - Establish network infrastructure - Provide training to users of the HIS - Provide maintenance - Receive payment

## 1.1.4. Restrictions On The Cost

The procurer establishes the budget for the project. The development team cannot exceed this amount within the confines of the project's defined requirements. The funding for the project is €1,500,000.00. The budget includes salaries for the development team (up to ten members), travel expenses, equipment and training costs. A financial plan has been established.

1.2. Introducing The System To Be Acquired

1.2.1. Users And Usage Of The System

Doctors at the primary health care centers are the sole users of the HIS. The procurer will provide the development team with a list of primary health centers and designated doctors who will access the system from the center. These doctors will have the ability to register new patients, upload existing patient data, manage patient information, schedule appointments, record and monitor lab findings, and manage prescriptions.

1.2.2. Expected System Context Diagram
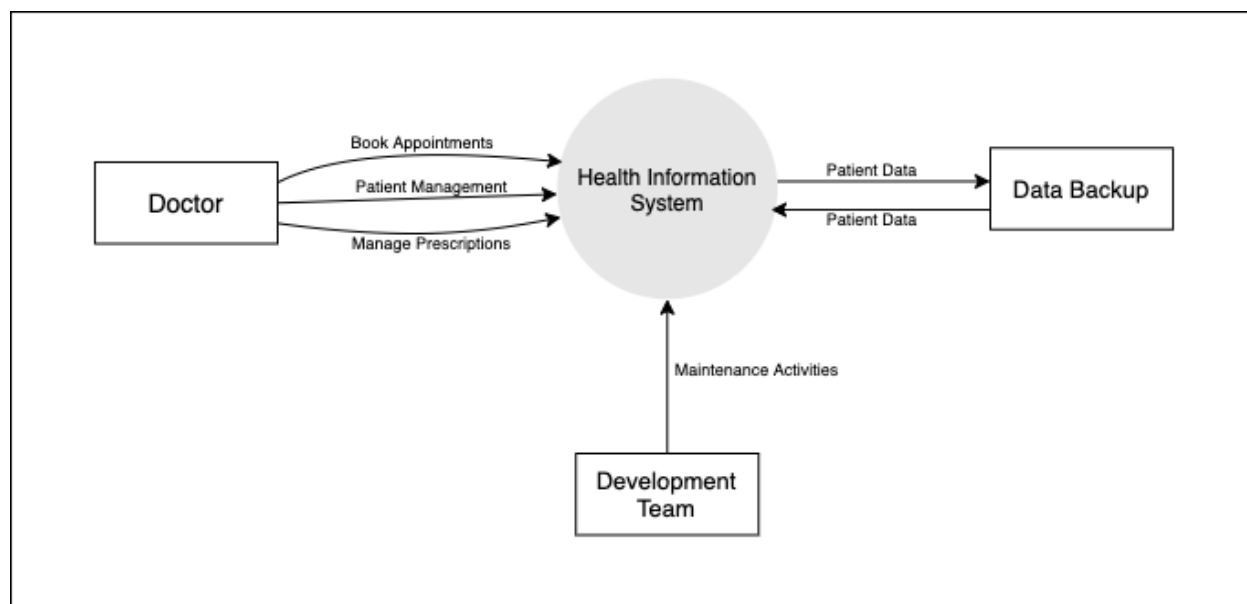
1.2.3. Components To Be Procured

The following are the components of the procurement:

- **HIS software**: To save time and development costs, an open-source HIS that fits the requirements shall be chosen.

- **HIS Installation**: The development team shall provide installation services of the HIS at the health centers. For installation, the HIS must include source code and the necessary documentation.

- **Established environment**: The development team will create databases and set up a local network at each health center. They will also set up separate backup spaces.

- **Training**: The development team will onboard doctors on the HIS and teach them how to use it.

- **Support**: The development team will provide maintenance and technical support for the HIS and the environment that has been installed.

1.2.4. Rights To Be Procured

The offered HIS shall be free to use and subject to legal restrictions on its use and modification. Additionally, the development team will give a warranty for installation services and development (if modifications are made) for the duration of the procurement period and a period of one year for post-contractual partnerships.

2. Developing the requirements

2.1. Functional Requirements

The functional requirements listed in the following tables specify functional (FR-001-012) and non-functional (NFR 001-010) requirements related to the procured HIS and related services. Listed requirements cover approximately 15 % of total requirements. Listed requirements were selected because they cover the core functionality of the HIS. In further developments (out of scope of current project) functionality for doctors can be expanded to include referral to lab or specialist from the HIS.

Use Case ID	FR-001
Use Case Name	New patient record
Primary Actor	Doctor
Preconditions	- The patient has a name and surname. - The name consists of Latin letters. - The name and surname are mandatory fields to create a patient. - The health centers assign each patient a unique ID. - The unique ID consists of 11 digits. - The doctors can add additional information (optional field): Patient's National Identification Number (NIN), address, sex, and date of birth.
Postconditions	A new patient record is created
Main Success Scenario	- The doctor enters the patient's name, surname and ID and creates a new Patient in the HIS. - The doctor can open the patient's record
Alternative scenario	The doctor cannot create a new record if a patient with the same name and ID already exists. The user will get a descriptive error message (e.g. user already exists, user name contains non supported characters)

Use Case ID	FR-002
Use Case Name	Add information to the patient record

Primary Actor	Doctor
Preconditions	The patient record exists in the database
Postconditions	Patient record is updated with new information
Main Success Scenario	- Doctors can add information about patient diagnoses, procedures, allergies, images, and medications. - Usage of special characters is not allowed. - Record row input limited to 300 characters
Alternative scenario	If doctors are unable to add the information, the system will present the user with a descriptive error that specifies the type of error (e.g. text is too long, using special characters is not allowed)

Use Case ID	FR-003
Use Case Name	Search for a patient by name or ID number
Primary Actor	Doctor
Preconditions	The patient record exists in the database
Postconditions	A list of patients that match the search criteria is displayed
Main Success Scenario	The doctor enters name or ID number (input) List of patients is displayed (output) The doctor can open the record
Alternative scenario	If the patient is not on the list, the doctor will receive an error message stating that the system cannot find the patient. The system offers the doctor the option to create a new patient.

Use Case ID	FR-004
Use Case Name	Creating new appointment
Primary Actor	Doctor
Preconditions	The patient record exists in the database The patient is not marked as deceased

Postconditions	A new appointment is created and added to patient information
Main Success Scenario	- The doctor can only create appointments for upcoming dates - The doctor can use only free time slots in the calendar to make an appointment - During appointment creation, the doctor cannot set an appointment end time that is before the appointment start time - The meeting shall be limited to one working day
Alternative scenario	If it is not possible to create a new appointment, the doctor will receive an error message with information about the type of error (e.g. selected date is not correct)

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

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	● The doctor finds the appointment that they want to delete. ● The doctor deletes the appointment and confirms deletion.

Use Case ID	FR-007
Use Case Name	Prescribe medication
Primary Actor	Doctor
Preconditions	The patient record exists in the database The patient is not marked as deceased
Postconditions	Medication is prescribed to the patient
Main Success Scenario	● Doctor chooses patient ● The doctor selects medication from a list of medication ● Doctor sets dosage ● The doctor sets the length of treatment

Use Case ID	FR-008
Use Case Name	Modify prescription
Primary Actor	Doctor
Preconditions	Medication is prescribed to the patient
Postconditions	Medication prescription is changed
Main Success Scenario	● The doctor opens an existing prescription ● The doctor can alter the dosage and length of treatment. ● Updated prescription available

Use Case ID	FR-009
Use Case Name	Cancel prescription
Primary Actor	Doctor
Preconditions	Medication is prescribed to the patient
Postconditions	Medication prescription is cancelled
Main Success Scenario	- The doctor opens an existing prescription - The doctor cancels the prescription - The prescription no longer exists in the system

Use Case ID	FR-010
Use Case Name	See appointment view for doctor
Primary Actor	Doctor
Preconditions	The doctor has access to the schedule
Postconditions	The doctor can open schedule and see upcoming and past appointments
Main Success Scenario	- The doctor opens the appointment calendar. - The doctor sees the upcoming and past appointment schedule. Doctor filters by daily, weekly, and monthly view - The doctor can open an appointment to see more information
Alternative scenario	In case there are no appointments, an empty calendar is displayed.

Use Case ID	FR-011
Use Case Name	Open radiological images
Primary Actor	Doctor
Preconditions	The radiological image exists in HIS Image is related to a particular patient

Postconditions	● The doctor can view the image within the HIS ● The image format is DICOM, JPEG, TIFF, GIF, or PNG
Main Success Scenario	The doctor selects a patient record The doctor selects a radiological image and opens it.
Alternative scenario	If the image is not in a supported format, an error stating "Format is not supported" is displayed to the doctor.

Use Case ID	FR-012
Use Case Name	Edit information about radiological images
Primary Actor	Doctor
Preconditions	The radiological image exists in HIS Image is related to a particular patient
Postconditions	Image Information is edited
Main Success Scenario	● The doctor can add notes (e.g. information about diagnosis, observation, treatment plan) to the image ● The notes are limited to 300 characters ● Doctor confirms change
Alternative scenario	If the note is too long, an error stating "Too many characters" is displayed to the doctor.

2.2. Non-functional Requirements

Use Case ID	NFR-001
Use Case Name	Secure password storage
Primary Actor	Doctor
Preconditions	The doctor uses email and password to access the system
Postconditions	Passwords are securely stored
Success Criteria	The system stores all passwords in hashed form.

Use Case ID	NFR-002
Use Case Name	Security - Data backup
Primary Actor	Doctor, Health center
Preconditions	Personal data about patients, including health data, is collected via HIS
Postconditions	The system backs up data and thus protects it from loss or unauthorised modification.
Success Criteria	- Data backup is performed every day at a set time. - Backups are stored in separate secure storage. - Backups are encrypted and protected from unauthorized access.

Use Case ID	NFR-003
Use Case Name	User interface language
Primary Actor	Doctor
Preconditions	The user interface of the system must be in English.
Postconditions	Developer who makes modifications to the system must add information in English
Success Criteria	All UI elements, error messages, input fields are in English.

Use Case ID	NFR-004
Use Case Name	The system shall be available 99.9%
Primary Actor	Doctor
Preconditions	The doctor needs to perform a task
Postconditions	The doctor has access to the system and can perform their tasks
Success Criteria	The system is critical for the health center and has the

	highest level of availability.

Use Case ID	NFR-005
Use Case Name	The software can be installed in Windows OS
Primary Actor	Doctor
Preconditions	Health centers uses Windows 10 OS on the computers (work stations for doctors)
Postconditions	The system is installed
Success Criteria	A responsible person from the development team provides the installation of software on the computers at each of the health centers.

Use Case ID	NFR-006
Use Case Name	Offline work
Primary Actor	Doctor
Preconditions	Health center has poor or no internet connection
Postconditions	Can work without internet connection
Success Criteria	The doctors can use the system offline with data syncs in the background when the system has an internet connection.

Use Case ID	NFR-007
Use Case Name	Users at a health center can use the system simultaneously
Primary Actor	Doctor
Preconditions	The system is installed on computers at a health center
Postconditions	The system allows all users at a health center work simultaneously

Success Criteria	All doctors can perform their tasks regardless of other doctors.

Use Case ID	NFR-008
Use Case Name	Legal requirements
Primary Actor	Doctor, Developer
Preconditions	Open-source HIS is selected for the project
Postconditions	They are no legal restrictions for software installation and modification
Success Criteria	- Doctors can use the HIS without legal limits. - The development team has the right to modify the open-source software to meet the requirements of the procurer.

Use Case ID	NFR-009
Use Case Name	Response time
Primary Actor	Doctor
Preconditions	The doctor enters data or performs a search
Postconditions	Data is inputted The search result is displayed
Success Criteria	- The system provides search results in 5-7 seconds due to the system's utilization of offline databases (depends on the complexity of the query) - Feedback on user input appears within 1 second.

Use Case ID	NFR-010
Use Case Name	Support - Code in a supported language with support from developers

Primary Actor	Developer
Preconditions	Open-source HIS project is written with a commonly used and supported language (e.g. typescript, java, .NET) and is currently supported by its developers
Postconditions	The development team in the project can make changes to the HIS source code and, if needed, can request support from HIS developers
Success Criteria	The selected HIS is written in commonly used and supported language (e.g. typescript, java, .NET)

3. Planning The Acquisition Activities

3.1. Software Development Life-cycle

The waterfall process will be the most suitable software process based on the project's scope, goals and the fact that it has a predetermined timetable and budget with restricted variants of flexibility. It will, however, be adapted to match project-specific needs. The project will consider the installation of a working environment in software development planning because it is a core part of the procurement asides software development. The following cycles will be used to carry out the development process:

- **Planning**

  The project's objectives, goals, and costs will be assessed during this cycle.

- **Define Requirements**

  In this cycle, relevant functional and non-functional requirements are defined.

- **Design and Prototyping**

  In this cycle, the health center's system architecture is defined based on requirements. Components such as local and backup databases and the health center's network system are outlined.

- **Software Development**

  Due to the fact that the current project is utilizing an open-source HIS, we shall determine the HIS's capacity to meet all requirements. If the HIS does not meet all needs, we will consider extending the HIS's functionality to meet those requirements.

- **Testing**

  In this cycle, software testing is performed. Testing is provided to ensure that the system works correctly. Automated and manual tests can be used for this task.

- **Deployment**

  In this cycle, the HIS becomes available to end-users. In the beginning, the HIS shall be installed at two health centers to ensure that all works correctly. After this is successfully done, the next step is installing and connecting the rest of the health centers. Also, this cycle includes training for doctors.

- **Operations and Maintenance**

  Maintenance is a necessary procedure to keep the HIS sustainable. The development team shall provide maintenance as part of a general agreement.

3.2. Participation Of The Procurer

The procurer and the receiving party (health center) will be involved in all phases of development. The open-source HIS will be chosen by the development team, but the procurer must approve it before moving on to the following stages. If needed, the development team will customize the open-source HIS to fit the procurer's specifications.

3.3. Main Risk

Risk	Mitigation strategy
Risk related to the system usage	
HIS is down or not responding	The development team provides technical support within 2 hours during one year. This period can be extended by an additional contract.
Doctor deletes patient record by mistake	The system creates backups every day, and the doctors can restore information from it.
Unauthorised person log in to the system	The development team restricts access to only safelisted IP addresses and logs authentication activity.
Doctor's understanding and acceptance	Since the health center is transitioning from paper-based record-keeping, the development team will training on using the HIS.
Unstable work of the HIS	The project will make use of open-source technology that is well supported. The development team will ensure proper technology level and installation.
Health center's computers becomes infected with a malicious program that affects HIS	The development team shall implement a strong anti-virus system, firewall, and other security measures to secure from cyber-threats.
Incomprehensible graphical user interface	The development team shall approve HIS selection with the procurer and health center representative before installation. In addition, the development team shall provide training for doctors regarding usage.

Need for maintenance	The plan for maintenance has been established along with the purchase
Data security	HIS handles sensitive personal health data, necessitating the use of industry-accepted standards.
Doctors may not have enough technical skills to use HIS	The development team will provide general training on how to use the HIS. The development team may provide additional training to doctors for up to one working day if necessary, with an emphasis on technical skills.
Administrative risks	
The development team may not have enough qualification	The procurer shall approve the developer's team. The unit shall consist of a project manager (1 person), software developer (up to 5 people), QA tester (2 people), technical support and maintenance (2 people)
The development team might change during the project delivery	The development team must affirm that they have no plans to leave the project throughout its execution. If another cause arises (for example, a protracted sick absence), the development team must confirm enough qualified team members to fill the void.
Communication risks	
Different understanding of project requirements by parties involved	Regular meetings shall be conducted to ensure that procurers, receiver and developer's vision and understanding of the state of the project is aligned.
Delays in the delivery	The project is divided into deliverable parts and in each stage, project readiness is confirmed and approved by parties .
Financial risks	
The risk of not having enough funding to finish the project	A financial plan is developed for the project. The procurer shall track it during each stage of the project.

3.4. Change management for requirements.

The procurer establishes an overall budget and plan for development. The development team and procurer must agree on a thorough development strategy that is consistent with the overall strategy. In general, throughout the development phase, only small alterations to the project and budget should be made. If alterations, such as a change in technology, are required, the development team must obtain approval from the procurer.

The budget for the project is fixed. Budget amendments are often forbidden. To ensure that the project is completed on time and on budget, all parties must adhere to the project's budget and development plan.

3.5. Acceptance plan

The main criterion for acceptance is that the system is used for its intended purpose and meets all requirements. Six months will be required to complete the project. Acceptance of the project as it will be delivered is summarized in the table below:

Action	Deliverable	Time
Planning - Defining project's objectives, goals, and costs	The documentation provided by the procurer	Performed before procurement
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
At this stage, the development team examines the present situation in the health centers, analyzes HIS requirements, selects and tests HIS to ensure that they meet the requirements, and may review several HIS if necessary.	● Proposal for selected HIS to procurer. ● Report of health center analysis provided by the development team to the procurer	One month
Development (optional) Developers shall select HIS that meets the maximum requirements of the procurer. In case not	Source code and documentation for HIS that meets procurer's	(optional) Two months

all requirements to HIS are satisfied, the developers team shall develop missing functionality and make changes in accordance to the procurer's requirements	requirements	
Establishing a health center environment: 1. Installation of the HIS software at two health centers 2. Establishing database 3. Establishing local network 4. Establishing a connection between database and software	Health center environment established. The report provided by the development team to the procurer	Two months
Testing the system performance: 1. Installation of HIS to 23 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
Deployment and training: The development team will provide common training for doctors from 25 health centres on how to use the system in a one-day (8-hour) training session followed by a one-day (8-hour) follow-up session after one week of use. On the day of the training, one person - a representative of the Procurator - will be present to confirm acceptance.	The doctors have received training from the development team. The development team will provide a report on training activities to the procurer.	Two months
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. Other sources of funds to cover future maintenance.