ISSN 2319 – 7595

Volume 12, No.3, May - June 2023

International Journal of Information Systems and Computer Sciences

Available Online at http://warse.org/IJISCS/static/pdf/file/ijiscs021232023.pdf

https://doi.org/10.30534/ijiscs/2023/021232023

Design and Implementation of Online Medical Laboratory Diagnostic System

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Received Date : April 08, 2023 Accepted Date : May 18, 2023 Published Date : June 07, 2023

ABSTRACT

The laboratory testing method in today's world, is inefficient and error-prone. Laboratory errors are inherently enigmatic because they are difficult to detect and, once discovered, are more difficult to comprehend than other types of medical errors. Medical errors, such as the loss of patient data and the mixing up of patient findings, can no longer be considered unavoidable, but can instead be actively minimized and prevented. In light of the COVID epidemic, this approach eliminates the necessity for direct physical contact between the laboratory technician and the patient being tested, as well as the resources and time spent bringing oneself to the hospital and waiting for a test that takes only a few minutes. This paper proffers a solution for the above stated issues and also provided a foundational framework for scalability. Prototyping software development model was adopted and use cases was for modelling of the system.

Key words: errors, patient, prototyping model, use cases testing.

1. INTRODUCTION

Health is incredibly vital for everyone. Unfortunately, almost everyone nowadays is suffering from at least one type of illness, such as bronchitis, pneumonia, hepatitis, back pain just to name a few of them. Due to rapid growth in the number of patients, more medical experts are needed. The government is having a hard time dealing with the issues of getting enough medical experts to get a good ratio among medical experts and patients.

Computer technologies have undergone a very drastic change and the aforementioned changes have also influenced many fields and revolutionized the way they function. One of the major fields whose landscape has been completely revolutionized by computer technologies is the medicine and healthcare field. The degree to which information technology promotes globalization refers to which various information technology tools are integrated into organizational activities,[1]. Also, [2] asserted that a significant paradigm shift has occurred in health care service delivery from an era of physician-centeredness to emphasis on quality of patient care; from isolationist practices by caregivers to networking in a global world, and from competition to collaboration among practitioners.

In line with this trend, computer technology has heralded numerous changes to the healthcare field covering the areas of organization of patient's data to the management of operating theatres. In addition, an operating and robust information system provides the right information to the right person at the right time with the lowest cost [3]. This is why pre-existing laboratory data management needs to be upgraded to a level that is sufficient to improve data quality, reduce the manual interfaces and intervention by laboratory technicians, and aid in timely and routine reporting of disease trends. The emphasis is on reducing the margin of errors made during transcription in the laboratories and provides a single point of entry for all patient and specimen data.

The process of going to laboratory diagnostic tests especially in a developing economy is incredibly stressful, time-consuming, and error-prone. The hours spent in waiting rooms both to take the tests and to obtain the results dissuades people from going for tests and properly accessing the state of their health.

With the introduction of an online web diagnostic system, the process will automate the management of the diagnostic centre making it more efficient and error-free. It aims at standardizing data, consolidating data, ensuring data integrity, and reducing inconsistencies. The benefits of using an online web diagnostic system are to provide a complete patient health record, to make a proper diagnosis and prescribe proper treatments; to track crucial medical information, consultation history, medications, and special conditions.

2. LITERATURE REVIEW

In recent times, technology has been a driving force behind optimization and changes in a multitude of day-to-day activities. Basic Laboratory Information System (BLIS), designed by [4] is a laboratory information system for resource-constrained environments. Test samples and related data are mostly managed in this system using non-standardized paper-based systems and human entry methods. The system is

built to work in resource-constrained laboratories with minimal information technology (IT) equipment, as well as across several sites with good, intermittent, or no internet access. There may be times when the laboratory's power source is unavailable. In such cases, it is critical to guarantee that the data in BLIS is compatible with paper records kept when there is no electricity. Despite the inherent inefficiencies of paper-based approaches, working with logbooks allows for more flexibility in data entry than working with an electronic information system. The system's drawbacks include the fact that it is not automated (patients must be physically present to register) and that appointment scheduling is done manually. As a result, the time it takes for a patient to be seen increases. As a result, the quality of healthcare services has deteriorated. [5] created a Web-based Integrated Health-Care-Management System. The patient module, doctor schedule module, and appointment module are the key modules in the system. This keeps a record of the patient's medical history (personal information, medical information, treatment information, payment information, and appointment information). It's a web-based system that helps keep track of all of patients' information, charges, and appointments. In addition, keeping a record of said doctor's appointments. This integrated web-based solution allows patients to utilize the system online and verify their appointments, reducing both the patient and the nurse's time and effort. Patients would also be able to check the status of their appointments and doctor availability online owing to this integrated web-based system. This gives you a complete picture of the patient's previous visits, including previous diagnoses, investigations, treatments, and medications. Additionally, it allows the user to order their tasks employing categories such as Urgent, High, Medium, and Low. However, it had one drawback: patients couldn't book appointments online or change their appointments' dates. Only manual records were preserved in the system, and they could only be obtained if the patient was physically present.
[6] designed a system that focused on the patient's appointment, which can be scheduled months in advance. When a patient wishes to see a doctor, they only need to call the health care provider and advise them of their desired date and time. The patient appointment is arranged if the appointment slot is available within a day or two of the specified date. If this is not the case, the patient must call back later. By decreasing no-shows caused by long appointment periods, has increased patient access to clinicians and reduced uncertainty in healthcare operations. Furthermore, in a static appointment, all scheduling decisions are made before the start of the session, but in a dynamic appointment, scheduling decisions are made as patients arrive.

3. STATEMENT OF THE PROBLEM

In the world we live today, and especially developing economies in particular, laboratory testing process is inefficient and error prone.

Errors in the laboratory are intrinsically obscure as they are difficult to identify and, when found, are less easily understood than other types of medical error. Medical errors such as loss of patient records and mix up of patient results can no longer be seen as inevitable, but as something that can be actively mitigated and prevented. In light of the COVID pandemic, this system will mitigate the need for physical contact between the laboratory technician and the patient to be tested, as well as reducing the cost of resources and time spent in the process of transporting oneself to the hospital and spending hours in waiting for a test that should takes less time.

4. AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to design and implement an online medical laboratory diagnostic system that automate the process of medical laboratory testing. The specific objectives are to:

i. eliminate the traditional approaches to physical contact tracing during the process of laboratory testing.
ii. remodel physical tracing using conserved location mapping and waiting time complexities
iii. implement the remodel using event driven programming
iv. Evaluate the developed system

5. METHODOLOGY AND SYSTEM DESIGN

The Prototyping development process model was adopted. A prototyping model is a model in which prototype are built, tested and reworked until an acceptable prototype is reached and achieved. The advantages of prototyping model are it leads to reduction in time and costs as defects can be spotted earlier, gives clear understanding of the system to the user, and increased user participation in the system before implementation. The figure 1 shows the phases in prototyping model.

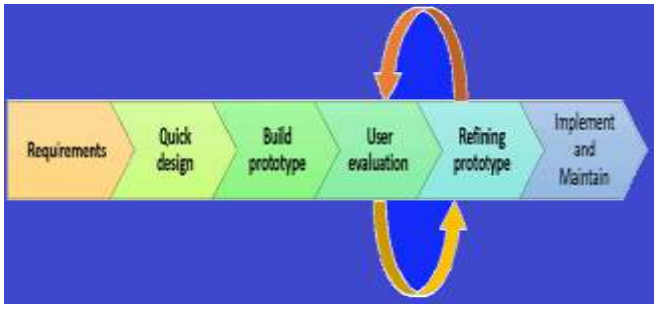

Figure. 1: Prototyping software development model [7]

Requirements gathering and analysis: In this phase the users/clients are interviewed to know what the system is expected to do and the requirements defined. The requirements are gathered at this early stage and essential for the succeeding stages.

Design: A simple design is drawn at this phase to give the users an idea of how the system prototype will be developed.

Build a prototype: A prototype (miniature working model) is designed and build based on the information gathered and created at design phase

User evaluation: the prototype is presented to the users/clients to discover the strengths, weaknesses, opportunities and threats to the system and feedback provided is used to improve the system

Refining prototype: This phase is for refining the prototype according to the users/client's feedback. This phase is iterative until all requirements defined are met and final system is developed.

System Requirements

These are requirements the system must meet in order to function optimally. The system in this project must meet the following two primary requirements:

Functional requirement: This are the functions the system should performed, they include:

- The system shall have the option to permit the user to identify if he/she is a patient or doctor
- Patients should be able to sign up.
- Patients should be able to log in.
- Patients should be able to book appointments.
- Doctors should be able to upload results
- Patient should be able to receive alerts when results are uploaded
- Patient should be able to pay for tests

Non-function requirement: This requirement is concerned about the system behaviour or quality attributes such as usability, reliability, performance, security, etc.

System Design

Unified Modelling Language (UML) was used to model the system. UML is a modelling language that incorporate use case diagrams in their formal definitions. Use case diagrams show the interactions between a system and its environment. Each use case represents a discrete task that involves external interaction with a system. Actors in a use case may be people or other systems [8]. In this project the patients and laboratory technicians

The figure 2 is the use case for the laboratory technician.

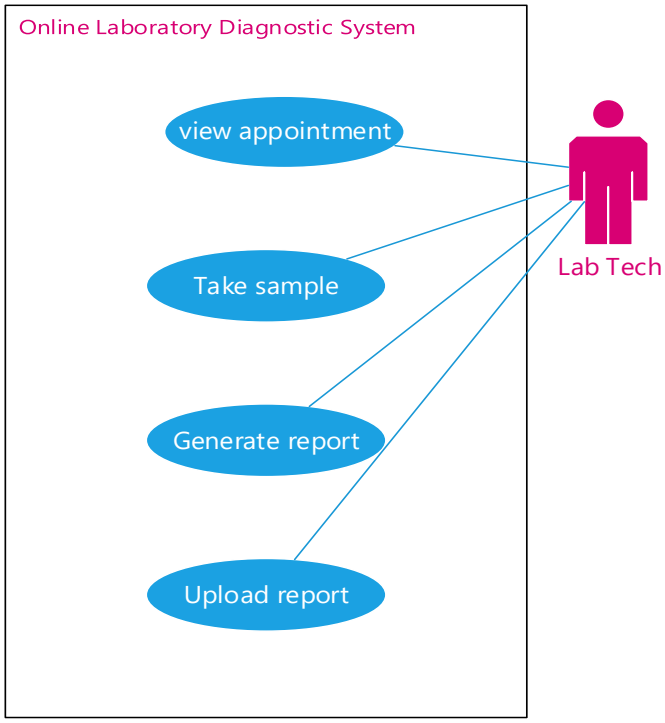

Figure 2: Laboratory technician use case

The use case for patient's is shown in figure. 3

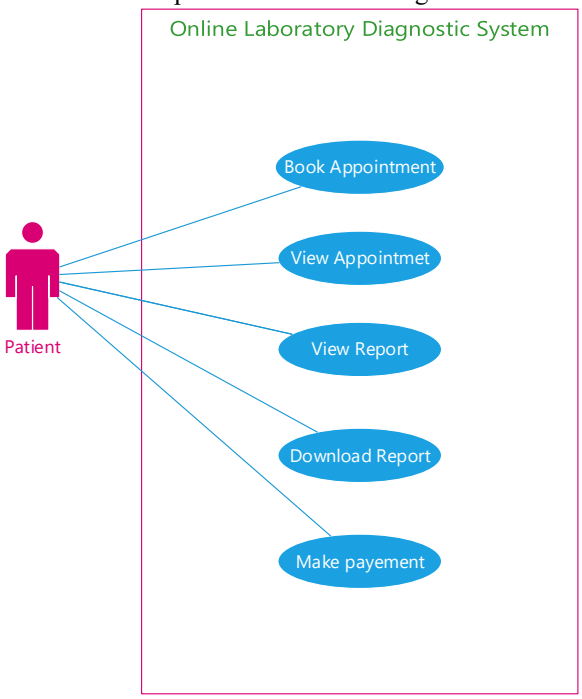

Figure 3: Patients' use case

ER Diagram

Entity-Relation (ER) diagram shows all the entities and their relationship in the system. Figure 4 depict the ER diagram of the system.

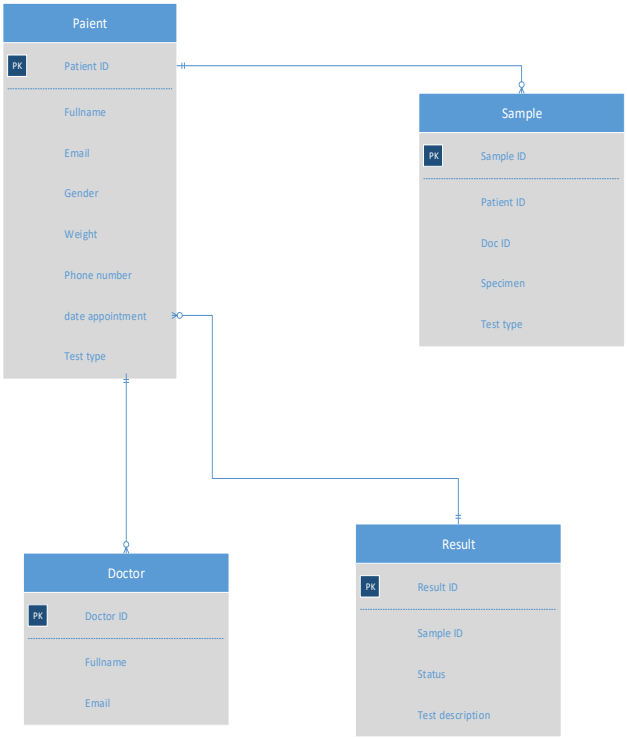

Figure 4. ER of Online Medical Laboratory Diagnostic System

6. SYSTEM IMPLEMENTATION

This is a stage where the system is put into action.
Figure 5 indicate the home page of the system where access is granted to the users/clients.

Figure 5: Home page

The service window shown in figure 6 allows user to select the type of service to perform.

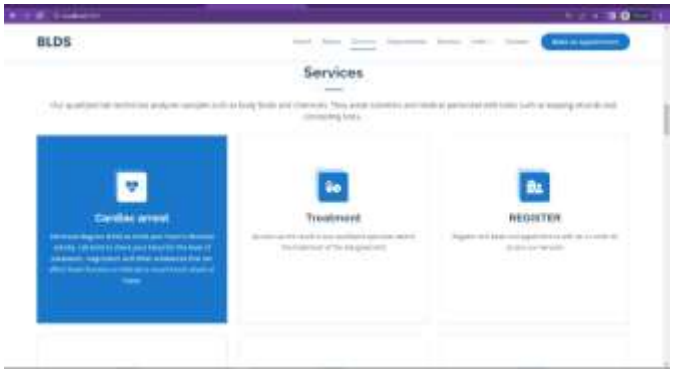

Figure 6 : Services window

The department window is shown in figure 7.

Figure 7 : Department window

The following is the login window that allows registered users into the system.

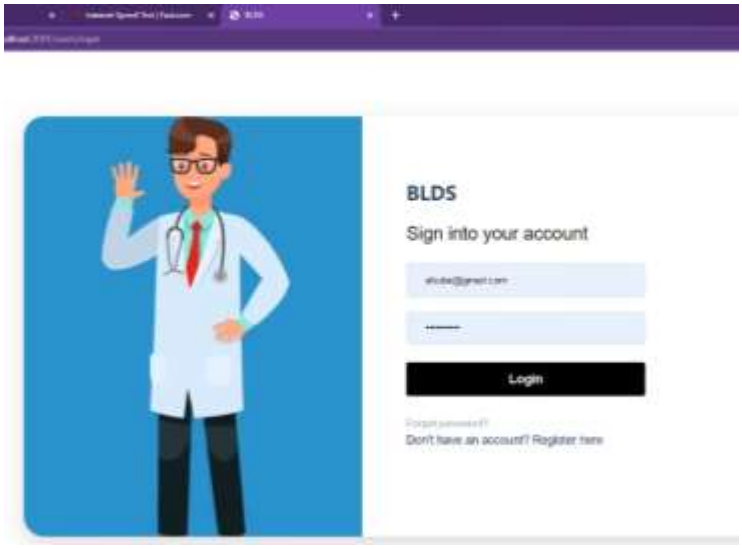

Figure 8: Log-in window

This appointment booking window allows the user to book their appointment and when they intend to take the tests as depicted in figure 9.

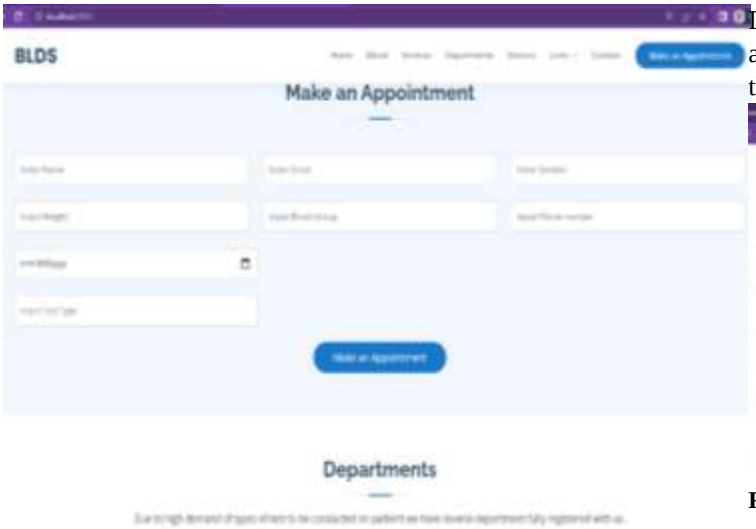

Figure 9: Appointment booking window

Successful booked appointment window is depicted in figure 10.

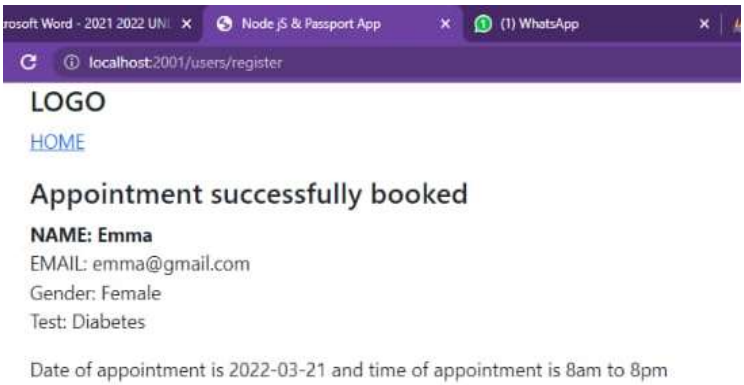

Figure 10: Appointment successfully booked window

Doctor's registration window in figure 11 allows the doctors to register for system usage.

Figure 11: Doctor registration window

Doctor's login window in figure 12 allows the lab tech to see all the appointments as well as the basic information about them.

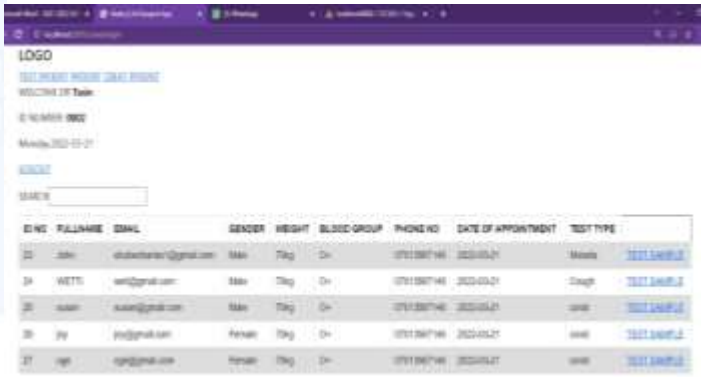

Figure 12: Doctors' login window

7. CONCLUSION

This project covers the significant aspect of medical laboratory diagnostic services. This solution was inspired by the post COVID crisis and the need for social distancing. This online medical laboratory diagnostic when successfully deployed will eradicate most challenges associated with manual medical laboratory services, such as location, distance, contamination, losses, etc.

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