



## Design and Implementation of a Web Based Health Information System

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### Abstract

Health Information System aims at improving and enhancing the delivery of quality, data availability and administrative effectiveness of people's health. Medical record has come under severe threat as a result of the manual system of medical record keeping in spite of its important functions. This system of record keeping involves taking down patient data on pieces of papers, which are put into files and kept in cabinets. In fact, this is an improper means of documentation resulting in loss and mismatch of patient data, and time wastage. It is also cumbersome, bulky and consumes a lot of the office space. In this paper, a complete web-based health information system is designed to solve these problems so as to enable users handle details on policies efficiently and effectively. A test of the system over various network topologies reveals that time taken to move a packet and received acknowledgement for standalone, LAN, WAN and Intranet is 3ms, 4ms, 8ms and 10ms respectively. These short periods of time show faster and efficient delivery of health activities. The Web Based Health Information System thus provides significant benefit to institutions as it can capture data and store it in the developed database for future use.

*Keywords:* Health information system, MySQL, Hospital Management, system development life cycle.

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## 1.0 Introduction

In the present era of globalization and advanced technology, efficient record keeping cannot be overemphasized. Each day, hundreds of patients enter healthcare facilities challenging the administration to meet their demand. The employees have to manage and integrate clinical, financial and operational information that grows with the practice. The number of investments in computers and types of health information systems has increased because electronic records are much easier to handle and improve the workflow efficiency by integrating the various tasks as compared to paper medical records which is cumbersome, bulky to use and difficult to manage (Health & Services, 2004; Kohn, Corrigan, & Donaldson, 2000).

Developing Web Based Health Information System (HIS) software to keep patient and health personnel records would benefit health centers and hospital management who would have effortless access to the data securely, more easily and remotely (Human, 2000; Park, Kim, Song, Song, & Chung, 2002). HIS is a system that is aimed at supporting the improvement of health care systems by increasing the capacity of health care workers to make decisions based on accurate information. Health information technology is the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, use of health care information, data and knowledge for communication and decision making (Sanchez & Lindstrom, 2012). It is an automated system that is used to manage patient information and its administration. Health information system is meant to provide the administration and staff with information in real-time to make their work more interesting and less stressing. It is used by hospitals to input process and display their patient information. This system is used to manage and maintain electronic medical records, patient information, prescriptions, lab reports etc. It is an effective tool in the hand of the health center, management and enhances networking among practitioners to share knowledge. During the automation, these records kept by these health centers and hospitals help in maintaining patient's medical records. The medical records must have correctly all of the patient medical history which includes patient's identity comprising; the patient's first name, last name, sex, age, address, family history, etc. These help in identifying the exact patient and his location as well as any family history (hereditary).

As an important source of patient information, the medical record facilitates the transfer of data to other health personnel who are involved in an ongoing treatment of patient or the transfer of patient to another physician/medical assistant at a different branch of the same health center. It also facilitates the transfer of data to health care establishment and other organization as well as stake holders such as Christian Health Association, Presbyterian Health Service, Ministry of Health and Insurance Company. This proposed web based health information system provides statistical data for national health planning delivery to increase access to health services and improve the efficiency of health service delivery. Also, it provides multi-user health management system to support the activities in various health centers.

Health care professionals now turn to various patient-centric technologies, including computerized patient records (CPR)(Hogan & Wagner, 1997), document management systems (Dourish et al., 2000; Zantout & Marir, 1999), data warehouses (Jarke, Lenzerini, Vassiliou, & Vassiliadis, 2002), point-of-care applications(Tokel, Inci, & Demirci, 2014), distributed networks(Harchol-Balter, Leighton, & Lewin, 1999), and telematics(Knockeart, Rode, & Delgiudice, 2005). While information needs drive the design of health information systems, sometimes even beyond a sustainable level of sophistication, resource considerations are equally important in health information system design and implementation. Though no two health information systems are alike because needs and resources differ within every country (Lippeveld, Sauerborn, Bodart, & Organization, 2000), all health information systems need a management structure. This management structure deals with two components namely health information system resources and organizational rules. Critical resources considered include personnel, supplies, computer hardware and software, and financial resources. Organizational rules are also very necessary to ensure the optimum use of health information system resources. The design and implementation of a health information system should be driven not only by the perceived need for routine information and its timely availability, but also available resources (Lippeveld, Sauerborn, Bodart, & Organization, 2000).

Beneficial uses of information and associated technology as it relates to health care improvement includes monitoring individual and organizational performance, facilitating information sharing among different health care organisation through a multi- agency approach, and empowering individuals by providing relevant information to consumers, thereby helping them to make informed choice. In the view of (Ajami & Bagheri-Tadi, 2013), there is the need to embrace information technology in healthcare in order to reduce medical errors, provide more effective methods of communicating and sharing of information among clinicians so as to better manage patient medical record. As technology continues its impact in healthcare according to the paper, the adoption of new information technology options has been able to reduce costs and increase efficiencies.

### *1.1 Problem Definition*

The absence of a well-established information system to serve patient and staff has led to inconveniences due to the weakness of the existing system which includes over reliance on paperwork. Paper files consume a lot of the office space, slow recording, processing and retrieval of patient details. Physical storage of documents is problematic as not all document types fit in the same size of folder or storage spaces. In general, medical records are on physical media such as film (X-rays), paper, photographs, often of different sizes and shapes. Physical records usually require significant amount of space to store them. Because paper records are stored in different location, copying, faxing, collecting and transporting them to a single or multiple location for review by a health care provider is also time consuming and costly. Furthermore, file cabinets used for keeping individual patient card enclosed in a file makes it very tedious in tracing record files and slow in processing of records. Moreover, paper records can be easily lost, misplaced and even often illegible. The use of electronic health record technology would eliminate these issues and lead to major improvements in the health and safety of patient care. This is achieved in this paper by designing and implementation of web based health information system. There are developed health information systems which are only on the local area network and accessible by a selected staff but not integrated into other hospital information systems or health information systems. Information about patient could not be accessed outside the institution with the help of a Virtual Private Network (VPN). The objective of the paper is to develop the patient and health workers database system and deploy it over a network.

## **2.0 Literature Review**

### *2.1 Hospital Management System*

A role based access control hospital management was proposed by (Boadu & Armah, 2014) where much attention was focused on the roles of the managements of the hospital and on the security of the system in terms of who should have authorization to which information. There was emphasis on the medical information and patient information which is indeed personal and stored in a database system. Even though database was implemented, it was the system administrator who registers patients and workers daily into the database. The administrator also backup details of the users and views saved process. Programming languages used in this research work were MySQL and C++. The MySQL was used to develop the backend of the system (database) while the front end was developed using C++. The program was written in c++ and it is also a stand-alone application. A stand-alone application does not need to run on a network because the data that is required is stored on that particular personal computer. Due to this the information of the patient can only be accessed at one point at a time and will not support data redundancy. Data redundancy is a condition created within a database in which the same piece of data is held in two separate places. However, writing the program to run on the network would have served a lot of purpose. Network applications utilize the client and server architecture in which there is a server and clients that are connected to it. Information of the patients can be accessed at any time everywhere on the local area network of the institution using this system. In as much as the security policies are acknowledged the system does not allow different departments to track activities of the users. For example, patient information cannot be accessed at records/reception and at the Outpatients Department (OPD) simultaneously. In effect it means that patient information cannot be available from any workstation. More so the system could not be linked and integrated into other hospital information systems or health information systems. Information about patient could not be accessed outside the institution with the help of a VPN. The discussion of financial matters, in regard to HIS implementation success for the hospitals, was also

missing from this study. Whether the HIS saved the implementing institution's money, and if this had any impact on workers' wages, is not known.

Health information system was also designed and developed using java as the programming language (Olamide, Adedayo, & Abiodun, 2015). Application of a relational database approach was utilized in constructing the Hospital management database. In this work readers are not provided the ultimate objectives of the designed system and so it is difficult to identify the objectives that the researcher deems fit to achieve in his work. More so the system does not provide any clue in respect to validation in the process of using the system. It could not tell who should have access to what data and who should not have access to which data. Roles have also not been given to users of the system hence a user at pharmacy for instance can have access to the same data that the records department has. Also, the work of the researcher clearly shows that admission department can interfere with the procedures of stores department. It must be noted that the researcher's ability to elaborate on the tools needed for the system design for the development would have served much importance to other researchers. The researcher did not make any comment whatsoever on the system design, system requirements and hardware requirement and the methodology that were employed. It is also difficult to determine the type of system development cycle that was implemented. Furthermore, there was little information on the researcher's choice of using Java programming language for the design and development of the Hospital Management System.

### *2.2 Electronic Health Record Systems*

The value of electronic health record was discussed in (Miller, West, Brown, Sim, & Ganchoff, 2005) where the importance of electronic medical records of the patient was considered to be very vital in the hospital administration and in the provision of a better healthcare to the patients. The electronic health record (EHR) uses some automatic presumed quality benefits such as improved data organisation, accessibility to data and information legibility. Increase in percentage in terms of patient visitation was also considered since the advents of an electronic health record of patient database can reduce the patient waiting time at the institution. Consistent use of EHR to document visit progress notes helped reduce the need for manual medical records of staff and transcription resulting in more complete documentation. However, it is important to note that the author did not tackle the system development and design. Much emphasis was rather on the financial cost and benefits of the system. Indeed, the importance of the data from the system for shareholders interpretation was acknowledged. It failed to discuss the tools that are needed for the design of such system, the system implementation and the relevance of the system. Also lacking in this study was information regarding the ability of nurses to use the HIS to summarize clinical data on patients. The system would not improve access for geographically isolated communities with health centers or hospitals. It does not provide support for the healthcare workers to aid in data sharing and therefore not an effective electronic means for data capture, storage, interpretation and management. In this context, the electronic health record system is supposed to be a tool that will facilitate the communication, processing or transmission of information by electronic means for the purpose of improving human health.

### *3.1 System Design of the Web Based Health Information Systems*

The method used in the design process is the system development life cycle (SDLC) (Kendall & Kendall, 2011). System Development Life Cycle is composed of a number of clearly defined and distinct work phases which are used to plan for, design, build, test, and deliver information system. It is a conceptual model used in project software management that describes the stages involved in an information system development project from the initial feasibility study through to maintenance of the completed application. This will help to produce high quality systems that will meet or exceed customer expectations, based on the customer requirements by delivering systems which will move through each clearly defined phase, within scheduled time-frames and cost estimates. Some of the types of the SDLC include V-Shaped Model, Spiral Method (SDM), Waterfall Model and Extreme programming (Agile development). Among these, the Waterfall model is used to design the HIS. The waterfall model is a sequential design process that is used in the software development process in which progress is seen as flowing steadily through the phases of conception, initiation, analysis, design, construction, testing, production or implementation and maintenance. This means that any phase in the development process begins only if the previous

phase is complete. It is easy to explain to the user and Stages and activities are well defined. It also helps to plan and schedule the project. Additionally, verification at each stage ensures early detection of errors / misunderstanding while each phase has specific deliverables.

### 3.2 Functional Component of the Web Based Health Information System

The various functional components of the proposed web based health information system are described in Table 1. The flow chart in Figure 1 gives elaborations on the administrator's roles.

Table 1: Functional Component of HIS

S/N	Components	Description
1	Administrator	Views all details of hospital record, creates, deletes, updates, and read information at any time without any restriction.
2	Inpatient module	Stores details of patients who are admitted
3	Outpatient module	Contains details of patients who come for clinical treatments or services.
4	Lab module	Used to enter lab details and reports of patients.
5	Billing/ Accounting	This is used to calculate the bill of the patient.

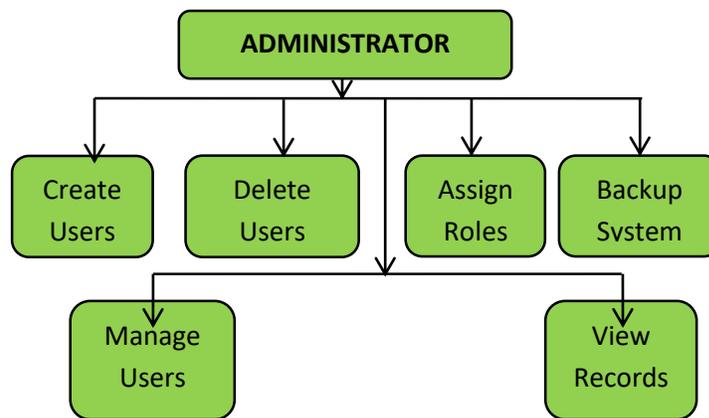


Figure 1. Flow Chart of Health Administrator's role

### 3.3 Description of the Health Information System Design

The health information system design involves stages including context flow diagram and data flow diagram. The context flow diagram is shown in Figure 2. It shows the system under consideration as a single high-level process and the relationship that the system has with other external entities like the entry of patient and user information into the Health Information System. As shown in the Figure 2, context flow diagram of HIS depicts the administrator / user access to the system after authentication and the user is able to perform activities such as laboratory reports, billing, patient's registration, or any query into the hospital database.

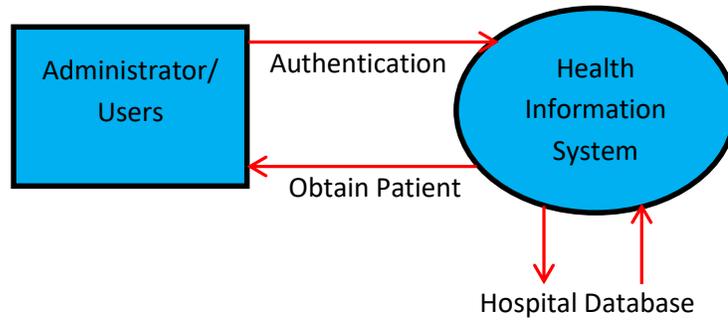


Figure 2. Context Flow Diagram of HIS

**3.4 Flow Chart of the Web Based Health Information System.**

The data flow is represented in Figure 3. As shown, it is a diagram of the sequence of movements or actions of people or things involved in a complex system or activity. It provides a graphical representation of the health information system in relation to its sequence of functions. The flow chart shows the activities such as admission, billing, pharmacy, etc. The admission process for instance takes either inpatient or out-patient details with the overall aim of entering them into the database. Also, the staffing activities ensures that staff details are registered into the HIS database. The other activities found in the flow chart follow similar explanation.

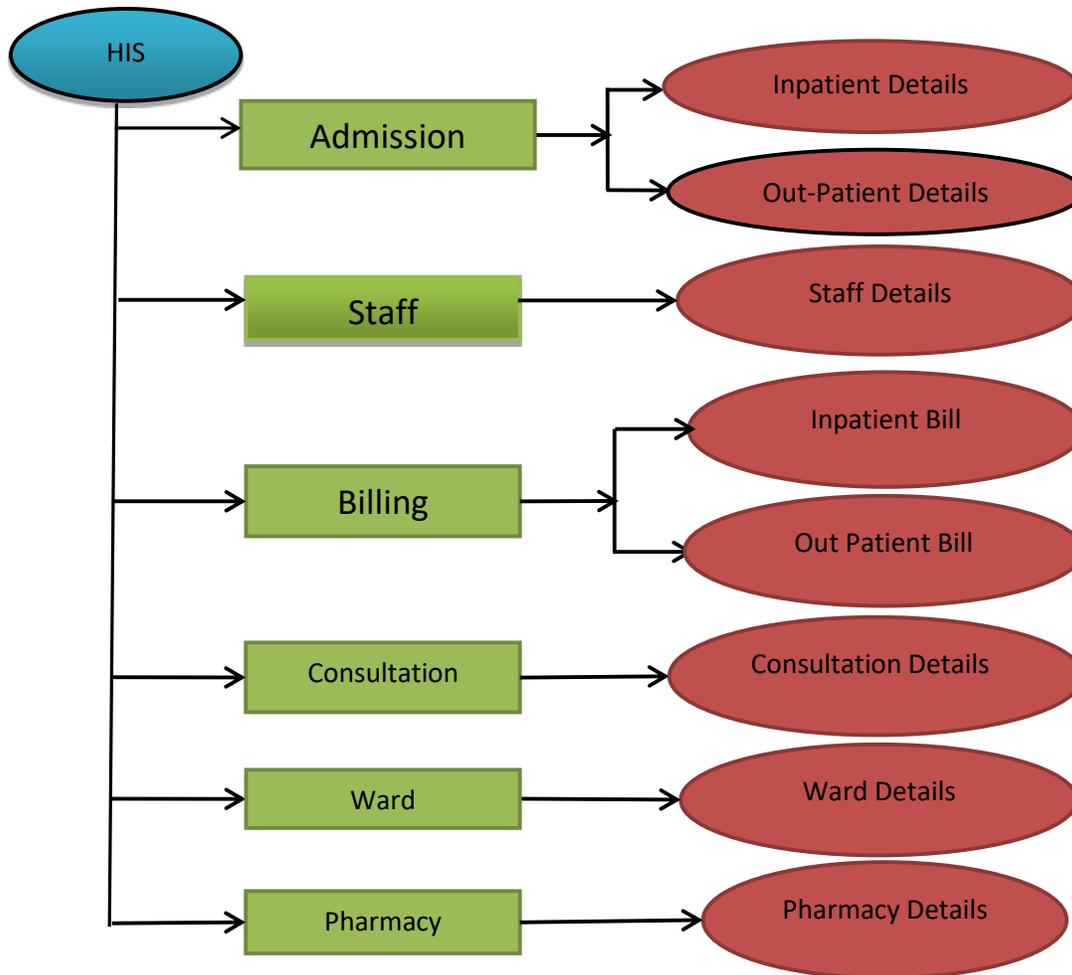


Figure 2. Data flow diagram for the web based health information system

### 3.5 Hardware and Software Requirements of Health Information System

The hardware specification that has been considered for this system is shown in Table 2. The software and their requirements are also listed in Table 3.

Table 2: Hardware Requirements of HIS

S/N	HARDWARE	CAPACITY
1	Disk Space (HDD)	80 GB
2	Memory	2.0 GB of ram and above.
3	Processor speed	1.0GHz and above
4	Network security	Firewalls
5	Router and Switch	24 ports
6	Antivirus and internet security	Kaspersky

Table 3: Software Requirements of HIS

S/N	Software	Requirements
1	Operating system	Windows XP, 7,8, Linux
2	Server	Windows server 2003/2008, Linux
3	Database	Microsoft SQL server / MySQL
4	Web server	Internet Information System, Apache

### 3.6 Designing and Development of the Web Based Health Information System Database.

The software development tool used in this paper are PHP/MySQL (Greenspan & Bulger, 2001), HTML and CSS. These software tools were chosen and used because of their unique features and ease of accessibility. The programming work of the entire system was carried out on two computers one which runs window server 2008 and the other uses windows 8 operating system. In the final implementation, the PHP/MySQL was tested on two computers which ran windows and Linux Mint. Windows and Linux operating systems were used to ensure compatibility of the PHP/MySQL, HTML and CSS with these two operating systems.

PHP is a server side scripting language created and designed for web development but also used as a general-purpose programming language. The PHP was used to make the interface a dynamic one and to also allow communication between the interface and the database. The interface is made up of HTML documents which are simply text documents that contain the content of the interface as well as special tags. These tags enclosed in brackets: < > provide instructions on how the text and graphics are displayed on the interface to allow users to make an input into the system. Typically, there is a starting and ending tag around text. The HTML governs the appearance of information on the webpage. MySQL was used in the construction of the database with all its tables needed for the HIS. MySQL is designed for three principles including performance, easy to use and simplicity. The designed tables in the database were connected to the interface to enhance interaction between the users of the HIS. Each table has a primary key and the data types of all the entities as well as the length of characters. All primary keys were given a length of eleven characters while other names such as surname, first name was given a data type of varchar. Scalability and ease-of-use features of SQL/MySQL server allow it to work efficiently on a client without consuming too many resources. SQL/MySQL server efficiently allocates the available resources, such as memory, network bandwidth, and disk I/O, among the multiple users.

### 3.7 System Login

Figure 4 represents the main system login page of the designed HIS. This login page accepts username and password of the user to be able to log into the system to access any file whatsoever. The information it accepts is sent and compared to the ones in the database and if there exist such a user the system gives authorization, otherwise access is denied. It is important to know that for a system to be ensured of security, requirements including Access, Identification, Authentication, and Authorization are imperative. In order to have access to the system login page remotely or over a health local area network, the following procedures have been followed.

- the internet is connected
- Browser is opened (internet explorer, fire fox, etc.)
- The required IP Address of the server is typed
- Username and a password in a login typed.
- Login is clicked.

If a correct identification is given, the main form is opened and the right form is activated. It is only after this that the user is given access to the main menu or the dashboard.

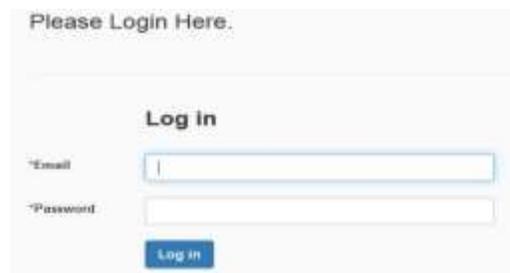


Figure 4: System Login

### *The Main Menu of the Health Information System*

Figure 5 shows the main menu which explains the other menus of the program as well as the accessibility options granted by the remote user or the administrators. To the left corner of the main menu is the side bar that offers a quick show of events or actions to be carried out while the top of the program is the list or features of various options in the menu bar to perform certain options. This main menu background gain has access to all files and data. It is divided into categories of Patients Registration, Consultation, OPD examination, Claims management, Reports Claims, Laboratory and Pharmacy management, and Human Resource management. It can add a doctor, register a patient, employee, view log reports, bill a patient, prescribe drugs for patient etc. A click on any of this will take a user to the respective menu for the necessary activities. For instance, that of the patient registration takes a user to the menu presented in figure 6.



Figure 5: Main Menu of the Web Based Health Information System

The patient registration form registers new patient who comes to the facility for the first time. On this form as shown in the figure, the details of the patient such as surname, last name, gender, religion, town, details of a relative, and the NHIS detail are saved into the database by clicking on the save button. The importance of the patient registration form is to keep all patient electronic folders into the database and thereby helping to achieve the objective of the system implementation. The OPD detail, a function of the hospital management is entered into the database by the system administrator.

Figure 6: Patient Registration Form

Nurses at the OPD could utilize this button to allocate the various rooms that the patient must visit to be attended to by the physician assistant or the medical doctor. The importance of this form is the fact that it accepts inputs which is then sent to the database for it to be retrieved at other departments which need the use of the information.

The Claims registration form is used to register NHIS details of patients which includes the scheme centre, card number, etc. The search button section enables the record department to search a patient upon his next visit to the facility.

#### 4 Results and Discussions

##### *Analysis of Real Time against Simulated System*

Figure 7 is a graph showing time for accessing the database as simulated in Packet Tracer. It describes the time for moving a packet from one computer to another and receiving acknowledgement using standalone, Local Area Network, Intranet and Wide Area Network for accessing the database. It can be seen from the graph that the time taken to move a packet and received acknowledgement for standalone, LAN, WAN and Intranet is 3ms, 4ms, 8ms and 10ms respectively. The design was also tested in the real world scenario using wireless medium. The actual run time for completing a transaction using different accessed mode for accessing the database in the scenario can be seen in Figure 8. Similar results on time taken to transmit a data and receive acknowledgement is shown in the figure with standalone, LAN, WAN and Intranet using 4000ms, 3000ms, 2000ms and 3000ms respectively. These times are very short enough to eliminate the bottlenecks as discussed in section 2. This information is indeed very important because users of the designed system do not care about the tools used in the system design but on the duration for which patient information can be entered into or retrieved from the database on the server.

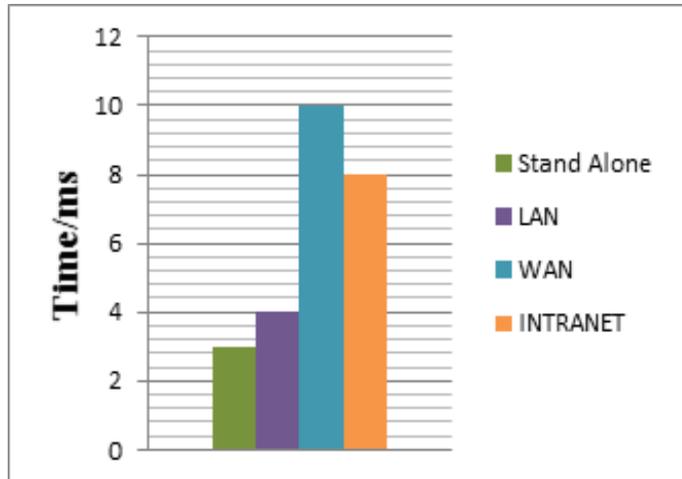


Figure 7: Time for accessing Data in a simulated environment.

For clearer comparative analysis, information from Figures 7 and 8 indicates time for transmission of data and reception of acknowledgement for the various network topologies shown in Table 4. From Figures 7 and 8 and table 4, time taken to transmit and receive acknowledgement in the simulation environment is faster. The longer time taken in the real world scenario as compared to the simulation environment is as result of factors such as interference in the wireless medium and speed of the internet or the bandwidth.

Table 4: Real time against simulation time for transmitting data and reception of acknowledgement.

S/N	Application Environment	Standalone	LAN	WAN	Intranet
1	Simulation time (ms)	3	4	10	8
2	Real time (ms)	4000	3000	2000	3000

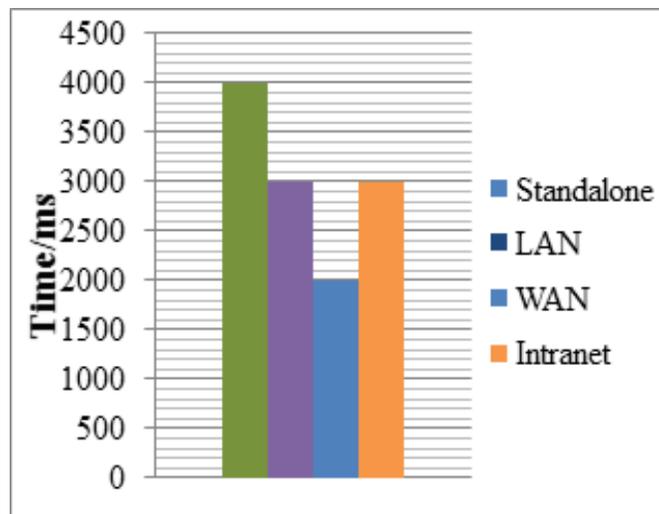


Figure 8: Real times for accessing the database

## 5 Conclusion

The web based health information system is developed using PHP, MySQL, CSS, HTML and Java Script. The system was deployed over a network using Xampp and Apache server to host it. The system was tested and run successfully on a standalone computer, LAN and WAN which breaches the gap between locally installed or desktop application, network application and the web application. Results show that 3ms, 4ms, 8ms and 10ms have been taken to transmit a packet and received acknowledgment on standalone computer, LAN, Intranet and WAN respectively in a simulation environment. On the other hand, similar results from a test in the real world scenario indicate 4000ms, 3000ms, 2000ms and 3000ms for standalone, LAN, WAN and Intranet respectively. The short period of time taken to access the system indicates that its implementation will decrease waiting time of patients and provide availability of patient records and timely statistical data for national consumption.

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