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Original Article

An Integrated and Secured Web-Based Electronic Health Record

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Abstract *- The unavailability of a central medical database to aid quick decision/policy making has warranted the need for an electronic health record system that is automated and more secure to improve medical information sharing across participating clinics in Nigeria. In other to achieve this, the researcher presented the increasing use of cloud services in the country as a viable option in deploying a web-based electronic health record (WBEHR) system using a subscriber identity module (SIM) card as a means of identifying the participating clinics through a web-based identification application programming interface on the WBEHR, and also the SIM card was pre-loaded with internet data and configured to access the WBEHR system only thus preventing abuse of internet usage by clinicians. The WBEHR was implemented in two private clinics in Sango Ota, Ogun State, for 30 days and subjected to a system usability scale (SUS) to determine its level of efficiency, effectiveness and satisfactoriness. Data was collated from 20 participants using a 5-point Likert standardized system usability scale (SUS) electronic questionnaire. A mean SUS score of 78.375 was derived, normalized into a percentile rank of 84 and grade B+ which implies that the system was generally acceptable by the users. With the implementation of this project, duplication of patient data will be eliminated, and the availability of a secured central database will encourage sharing of clinical data among the relevant stakeholders in the health sector, thus informing timely decision-making.*

Keywords *- Electronic Health Record, System Usability Scale, Unique Patient Identifier, Web Based Application Programming Interface, WBEHR.*

1. Introduction

Health Information Management System is an important aspect of health care services delivery because it forms the basis through which decision is made by caregivers. The core components of this system are data generation, compilation, analysis, synthesis & utilization [1]. It is also referred to as E-Health by so many academic institutions, individuals and other stakeholders in the health sector; it is a more recent concept that uses the internet and other technological tools to facilitate information delivery for more effective decision-making [2]. Basically, E-Health is grouped into three distinct categories, namely, Electronic Health Record (EHR), Electronic Medical Records (EMR) and Personal Health Records (PHC) [3]. An Electronic Health Record (EHR) can be defined as the electronically maintained record about a patient made available to multiple legitimate users of the record [4]. It allows sharing of a patient's health status among various hospitals and doctors if necessary, while an Electronic Medical Record (EMR) is the health information of a patient in a digital form and is often created and managed by Doctors and other staff within one healthcare organization. On the other hand, a Personal Health Record (PHC) is an electronic format of an individual's health record conforming to national standards but being managed and controlled solely by that individual [3].

Nations across the globe have developed their own technology geared towards a national electronic health record system; it is noteworthy to investigate how some of these countries have been able to achieve it. Singapore uses a national patient index managed by a company called MOH holdings [6], New Zealand uses a medical alert system which is made possible through point-2-point communication between various hospitals [7], Germany's national health system is based on telematics, an interdisciplinary field encompassing vehicular technology, computer science, telecommunication and electrical engineering [8], Canada uses a distributed system comprising of a cluster of EMR's solution that is managed by a company called Infoway.

It is based on provinces [9]; the Australian government created a My Health Record, a unique identifier for its citizens. Denmark, France & Taiwan have issued personalized electronic medical record cards embedded with chips storing patient medical records of citizens tenderable in clinics, Hospitals in countries like India, Israel, China and Brazil use different electronic medical record systems, achieving a nationwide electronic health record system is yet to be implemented [10].

There have been few instances of electronic health in Nigeria. Lagoon Hospital, a private clinic in Lagos, became the first in Nigeria to integrate an electronic medical record system on the 30th of October, 2013 [11]; Kogi State Specialist Hospital is one of the few public hospitals in the country that uses an integrated electronic medical record system [12], A web-based electronic medical record system was implemented for Federal University Wukari (FUW) clinic [13]. Even with these few innovations across the country, achieving a national electronic health record system that would encourage sharing of patient medical records still remains elusive because most hospitals in the country, either government or privately owned, do not have an electronic system that can be harmonized together to become interoperable.

2. Statement of the Problem

Paper registration for years has characterized the operation of most hospitals in Nigeria, thus making it difficult to achieve a centralized health database. Some of the issues associated with the manual health registration system in the country are listed below:

- Duplication of patient data across the country.
- Unnecessary time delay in attending to patients due to tedious storage and retrieval processes, most especially in a large health facility.
- The unavailability of a central database for prompt information delivery in terms of birth rates, mortality rate, and disease surveillance for effective decision-making and proper planning nationally by the appropriate agency of government.

Hence to address these aforementioned issues is the development and implementation of a Light weight and user-friendly web-based electronic health record system using subscriber identity module (SIM) card authentication. The purpose of the SIM card is to serve as a means of identification for the participating clinic that intends to use the online health record through a web identification application programming interface (Web Identification API). This is necessary to secure patient records and to monitor the activities of the participating hospitals using the web record services in real-time. Also, the SIM card is expected to be inserted into a wireless router within the health facility, pre-loaded with internet data, configured and restricted to access only the web-based electronic health record system through content filtering to prevent the abuse of internet usage by clinicians.

3. Literature Review

Numerous researchers have carried out investigations and improvements on Electronic Health Record (EHR). A few among recent publications on this subject are discussed based on their adopted methodology and limitations in the table below-

Author	Method	Contribution	Limitations
[14]	Utilized unified modeling language (UML), HTML, CSS and JavaScript to develop a cloud-based electronic medical record (EMR)	The system advanced role-based access to medical records as against the use of biometrics.	The performance of the proposed system was never evaluated. The system was not designed to be interoperable.
[13]	Older versions of web programming tools (HTML, CSS & JavaScript) were used to develop and implement a prototype web-based electronic medical record (EMR).	All the health processes in the federal university Wukari clinic (FUW) were automated, leading to an efficient retrieval and storage of patient medical records.	The security of the WBEMR is not too adequate in encouraging clinicians to have access to patient records outside the clinic.
[16]	.Net development and CACHE were used to design a Brower/Server framework.	A template maintenance program was developed to assist patients requiring further assistance after their discharge from the hospital	Security measures to protect the proposed system were never considered for the patients.
[17]	CarePlus EMR was deployed in a hospital to evaluate the level of acceptability of electronic health by clinicians.	Clinicians appreciated the use of electronic medical records (EMR) software in automating their activities at Kogi state	CarePlus EMR software used in this work is platform dependent and not interoperable to encourage sharing of medical

		specialist hospital.	records with other hospitals.
[18]	Visual Studio 2008 Integrated development environment (IDE) and MySQL server were used to develop an NHMS web platform model.	Findings revealed that the model developed had the capability of handling homogenous and heterogeneous systems using a variety of operating systems.	The proposed system is not practicable for large databases because it requires high-end equipment and infrastructure where servers will need to be installed in several locations in order to encourage physical security.
[19]	Unified modeling language (UML) – Activity, sequence and use-case diagram were used to model the proposed system to integrate activities in the National health insurance scheme (NHIS)	The prototype system was evaluated to determine its Mean Opinion Scores, which were found to be generally accepted by users.	The system developed in this work was only found applicable to automate all activities in the National Health Insurance Scheme and cannot be used in any hospital because it is neither an EMR nor EHR system.
[20]	HTML5, CSS3, JavaScript, Bootstrap and MySQL were used to develop and implement a web-based electronic health system (WBEHS)	Clinicians in Shorsh general hospital in Slemani city found the new system very efficient in the discharge of their duties.	Though deployed on the web, the new system is basically an EMR system design for use only in the hospital, thus not encouraging sharing of clinical data across various hospitals in the country.
[15]	An EMR system was developed using Visual Basic 6.0 and Microsoft access	The proposed system (e-medical record system) met the user's requirements at Federal Medical Center, Lokoja.	Visual Basic 6.0 is basically a procedural language and not object-oriented programming; thus not adequately secured. Also, the new system is an EMR system; thus, it will not support sharing of patient medical records outside the clinic.
[22]	Cloud-based electronic health record called Sijilli which involves the use of a key-shaped USB allocated to participants.	This encourages a national health record system in Syria.	The study did not extensively discuss the security architecture of Sijilli in terms of patient privacy.

The limitations of systems with reference to [5], [13] [14], [15], [16], [17], [18], [19], and [20] in comparison with the proposed WBEHR is that the aforementioned systems had security issues, even though some of the systems were deployed on the web, they were basically electronic medical record (EMR) systems applicable for use in a particular clinic thus not interoperable to encourage sharing of patient records with other hospitals. In developing an interoperable system that will be readily available anywhere in Nigeria, the issue of adequate security of patient records(identifying the participating hospital using the system in real-time, the number of devices that logs into the system within the hospital premises and preventing clinicians from using the system when outside the participating hospital's premises thus removing abuse of patient medical record), ease of use (a system that clinicians will easily adapt to without any rigorous training) and cost-effective internet(connecting participating hospitals in such a way that clinicians will not abuse the use of the internet by restricting access to other websites except for the WBEHR portal) were taken into consideration in the design stages of the web-based electronic health record system.

4. Methodology

This section elaborates on all the phases involved in developing the web-based electronic health record, which includes planning, organizing and building up every component required to make the proposed system functional. Based on the incremental model of the system development lifecycle and through unified modelling language (behavioural modelling using use case and activity diagram), every unit component required for the electronic health record system is tested and improved on to achieve an efficient and workable system. The database layer and its relationship with other components were made possible using an entity relationship diagram. The hardware components used in the development of this work include a 500GB HDD, 4GB RAM, X-64 based processor, 2.16GHz, Intel ® Celeron CPU, A SIM card and a Wireless router.

5. Assumptions Made in this Work

- That every participating clinic must have an ICT-compliant and support staff.
- That every participating clinic must have been issued a Subscriber Identity Module (SIM) card for identification by the appropriate agency managing the central portal.
- Every participating clinic must have an active e-mail address.
- It is also assumed that regulating agencies for the health practitioners (Doctors, Pharmacists and Lab technologists) that would be using the EHR system do have a verifiable database online.

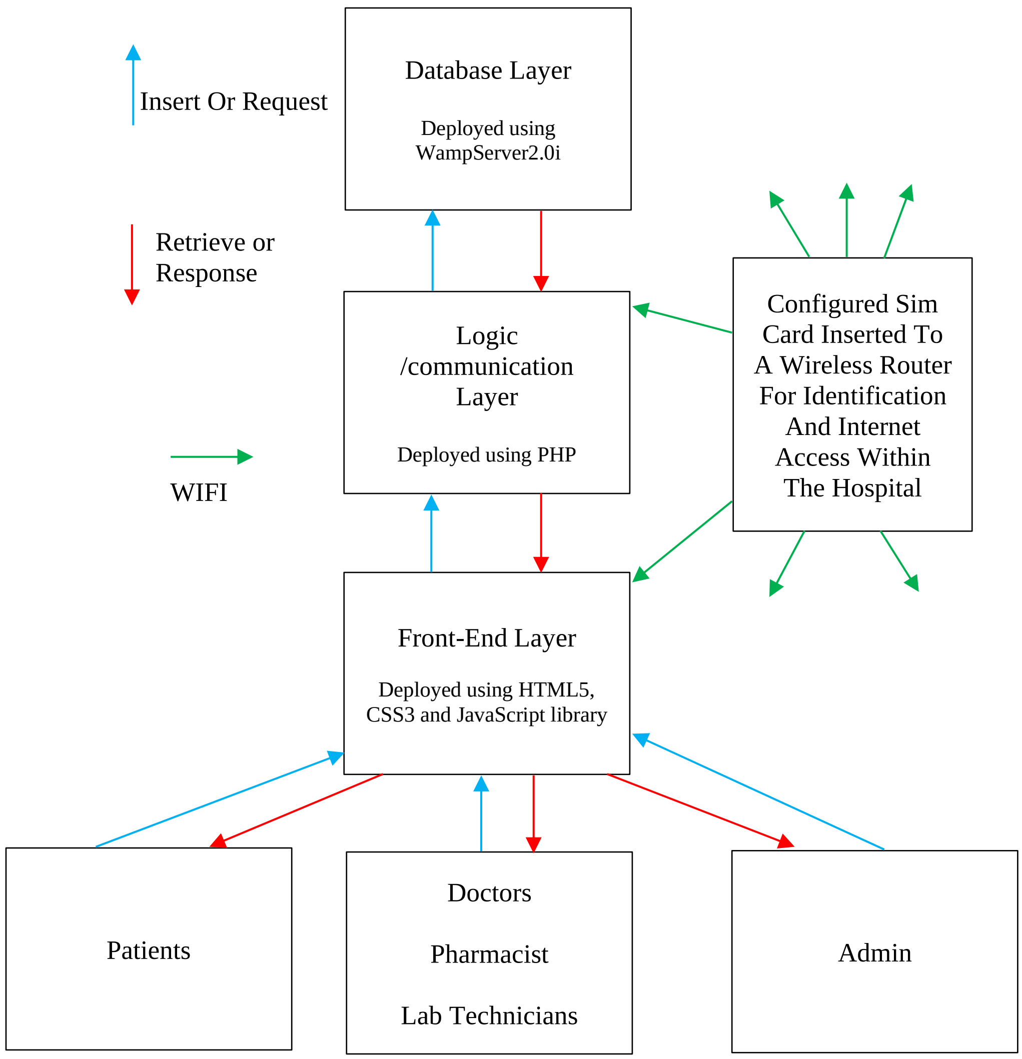

Fig. 1 Architecture of the WBEHR

6. Architecture of the WBEHR

The proposed web-based electronic health record will have three layers, namely front-end, logic, database and a configured SIM card for internet access only to the WBEHR portal.

- Front-end layer: This is the user-friendly mobile interface that crops up on any internet browser for the end users. It is based on HTML5, CSS3 and JQuery (JavaScript library)
- Logic/communication layer: This is the layer that acts as the means of communication between the front-end and database layer. It was coded in PHP (server-side), the most populous language of the web, with over 80% of the world's web running on it globally.
- Database layer: This layer stores all data coming from the front-end. It is based on My Structure Query Language (MySQL) with key words such as "SELECT", "CREATE", "DELETE", "INSERT", and "UPDATE" used often. This is deployed using WampServer 2.0i.
- SIM Card: In the context of this research, a SIM card was used and configured through content filtering to restrict accessing other websites online except for the WBEHR portal. Also, SIM integration on the web meant for the identification of participating clinics was made possible by providing a web identification application programming interface (api).

7. Result

After implementation, some screenshots of the new application have been detailed below to show the internal working. A unique patient identifier is generated for a new patient after he or she has been captured in the database, as depicted in Figure 2.

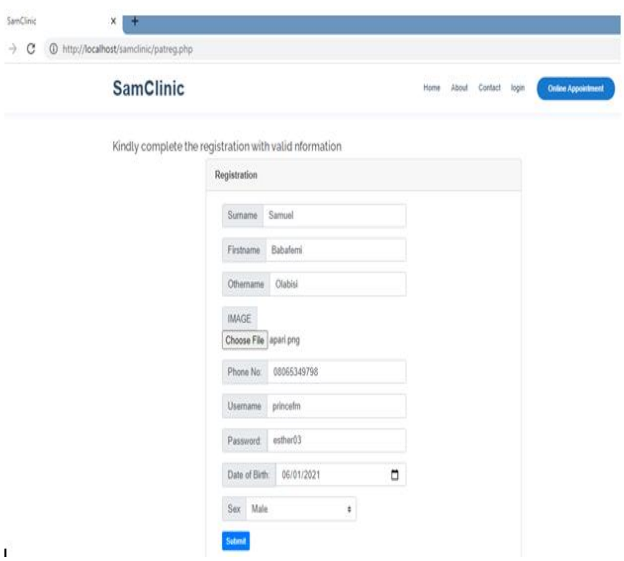

Fig. 2 Unique Patient Identifier Generated for New Patient

The Patient Identity (PatientId) generated by the WBEHR and the password created by the patients during their registration becomes the login parameter to access the system, as shown in Figure 3.

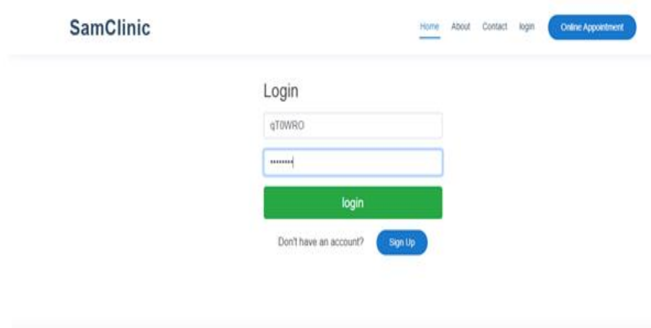

Fig. 3 Login page for patients

Patients are allowed to book an appointment, make complain and check their appointment history, as shown in Figure 4.

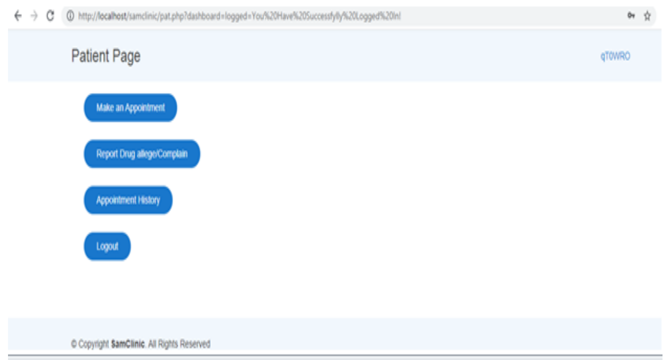

Fig. 4 Patient module

This page accepts the participating clinic-allocated mobile ID, the name of the clinic (Clinic 1 or Clinic 2), the number of devices expected to be used in the premises of the hospital for a specific date, based on these parameters, a private key (an access code) generated randomly by the web identification API is sent to the participating clinic e-mail address. The access code will only be valid on the date specified and for the number of devices chosen by the ICT support staff. This is necessary to identify the participating clinic using the WBEHR in real-time and also to monitor the activities of the healthcare practitioners using the system to prevent abuse of patient data. This implies that clinicians can only access the WBEHR when the participating clinic they are attached to has been identified. This is depicted in Figure 5.

Participating clinics must be identified on the WBEHR by a unique key (access code) which must have been sent to the hospital's dedicated E-mail address, and then it is expected that the ICT support staff of the clinic inputs it on the number of devices specified for that day. It is when the participating hospital have been identified only then can clinicians be prompted to validate their professional membership before having access to the WBEHR system, as shown in Figure 6.

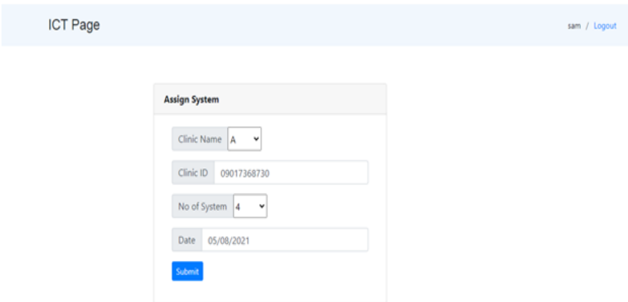

Fig. 5 Screenshot of the Web Identification API Page for participating clinic on the WBEHR.

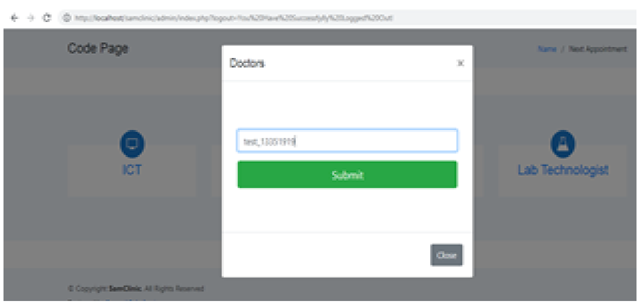

Fig. 6 Access code authentication for devices within the hospital premises

This page only comes up for clinicians (doctors, pharmacists and lab technologists) after the participating hospital has been identified by a private key (access code) generated by the WBEHR. This page attempts to validate the membership of a healthcare worker with their license regulatory agency, e.g Nigerian Medical Association (NMA), Pharmacist Council of Nigeria (PCN) etc., before granting access to clinicians. A demo database was designed and populated to be validated by the WBEHR system, as shown in Figure 7.

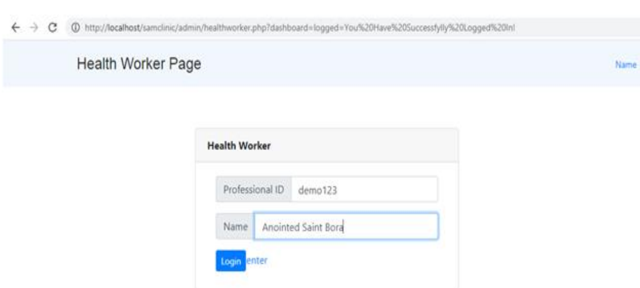

Fig. 7 Authentication for clinicians

The doctor's module on the WBEHR allows access to patient complain, laboratory tests, prescribe drugs etc., by querying the database with the unique Identifier of the patient (PatientId), which becomes a foreign key linking all tables. A screenshot of the doctor's module is depicted in Figure 8.

Fig. 8 Screenshot of doctor's module

8. Evaluation of the Wbehr

The new system was implemented in two private hospitals in Sango Ota, Ogun state, for 30 days and was subjected to System Usability Scale (SUS) to determine its level of satisfaction, effectiveness and efficiency. An electronic questionnaire was used to collate data from 20 participants who were computer and internet savvy. SUS consists of ten (10) standardized questions based on Likert Scale where Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4 & Strongly Agree = 5. SUS uses a complex scoring system because it comprises five (5) positive odd-numbered questions and five (5) negative even-numbered questions.

SUS score = (X +Y) * 2.5 where

X = Add up the total score of all odd-numbered questions, then subtract 5 while

Y = Add up the total score of all even-numbered questions, then subtract from 25.

Table 1. SUS Scores for Users of the Web-Based EHR using 5 – Point Likert Scale

	Qu1	Qu2	Qu3	Qu4	Qu5	Qu6	Qu7	Qu8	Qu9	Qu10	SUS	NPS
User1	5	1	3	3	5	2	5	1	5	1	87.5	Promoter
User2	5	2	4	1	4	1	4	3	5	2	82.5	Promoter
User3	3	1	4	3	5	2	4	2	5	3	75.0	Passive
User4	4	2	5	2	3	3	3	2	4	2	70.0	Passive
User5	5	2	4	1	4	2	5	1	4	2	85.0	Promoter
User6	5	2	4	2	5	1	4	2	4	3	80.0	Promoter
User7	4	1	5	2	4	3	4	3	5	2	77.5	Passive
User8	4	3	2	2	3	1	5	2	4	1	72.5	Passive
User9	5	3	5	1	5	2	4	3	3	2	77.5	Passive
User10	3	3	4	1	4	3	3	1	5	3	70.0	Passive
User11	5	3	5	2	5	2	5	2	4	2	82.5	Promoter
User12	4	2	5	3	4	3	5	1	5	3	77.5	Passive
User13	4	1	4	2	4	2	5	3	5	1	82.5	Promoter
User14	5	3	3	1	3	1	4	3	4	2	72.5	Passive
User15	5	2	3	3	5	2	4	2	4	1	77.5	Passive
User16	4	2	4	2	5	1	5	3	3	2	77.5	Passive
User17	5	2	4	2	5	3	4	3	4	3	72.5	Passive
User18	3	1	5	1	4	2	3	2	5	1	82.5	Promoter
User19	5	3	5	1	4	1	4	1	5	2	87.5	Promoter
User20	4	2	4	3	4	1	4	2	5	2	77.5	Passive

Interpretation of Results: The lowest and highest SUS scores for the web-based Electronic Health Record stated as 70.0 and 87.5, respectively. A Mean SUS score for the Web-based Electronic Health Record = (Sum of all SUS scores for Users ÷ Total number of Users) was generated. Sum of all SUS scores for users = 87.5 + 82.5 + 75.0 + 70.0 + 85.0 + 80.0 + 77.5 + 72.5 + 77.5 + 70.0 + 82.5 + 77.5 + 82.5 + 72.5 + 77.5 + 77.5 + 72.5 + 82.5 + 87.5 + 77.5 = 1567.5
Mean SUS score = 1567.5 ÷ 20 = 78.375.

System Usability Scale (SUS) scores become meaningful by normalizing scores to produce percentile ranking.

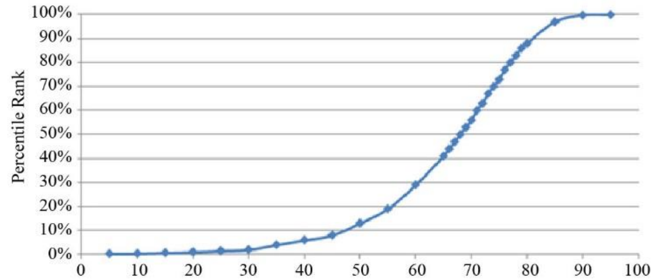

Fig. 9 Percentile Rank for Common Raw SUS Scores
Source: Five ways to Interpret a SUS Score by Jeff Sauro, 2018

Table 2. Percentiles, grades, adjectives, and NPS categories to describe raw SUS scores

Grade	SUS	Percentile range	Adjective	Acceptable	NPS
A+	84.1-100	96-100	Best Imaginable	Acceptable	Promoter
A	80.8-84.0	90-95	Excellent	Acceptable	Promoter
A-	78.9-80.7	85-89		Acceptable	Promoter
B+	772-788	80-84		Acceptable	Passive
B	74.1-77.1	70-79		Acceptable	Passive
B-	72.6-74.0	65-69		Acceptable	Passive
C+	71.1-725	60-64	Good	Acceptable	Passive
C	650-71.0	41-59		Marginal	Passive
C-	627-64.9	35-40		Marginal	Passive
D	51.7-626	15-34	Ok	Marginal	Detractor
F	25.1-516	2-14	Poor	Not Acceptable	Detractor
F	0:25	0-19	Worst Imaginable	Not Acceptable	Detractor

Source: Five ways to Interpret a SUS Score by Jeff Sauro, 2018

From Figure 9 & Table 2, a raw SUS score of 68.0 denotes a percentile rank of 50th percentile. This can be interpreted that a SUS score of 68.0 implies that the system is deemed average; a SUS score below 68.0 means that the system is below average, and above 68.0 indicates that the system is above average. In this case, the average (78.375) and lowest (70.0) SUS score, respectively, for the web-based EHR is an indication that the proposed system is above average, implying a percentile ranking of 84 and grade B+, indicating that the system was generally acceptable, that the users are passive and will not discourage others from using the proposed system if deployed on a larger scale.

9. Conclusion

In designing the Web-based Electronic Health Record (WBEHR) for Healthcare Organizations in Nigeria, the researcher looked critically at the unavailability of a central database to share patient medical records in the health sector, thus leading to delayed and untimely decision-making by the appropriate stakeholder. Also, it was identified that the huge cost of procuring internet for each hospital, even if a web-based electronic health record is deployed, would be another issue that will mitigate against its adoption; hence the researcher proposed a system where a configured and pre-loaded subscriber identity module with internet data should be allocated to participating hospitals. The purpose of the subscriber identity module is to identify any of the hospitals that will be using the web-based electronic health record for tracking information in real-time and a means of accessing the internet by these hospitals. In this case, the subscriber identity module is inserted into a wireless router that has been configured to access the electronic health record portal only to prevent abuse of internet usage by clinicians. It was observed from the implementation and mean SUS score (78.375), taking into cognizance experience (in terms of satisfactoriness, efficiency and effectiveness) generated from users' responses, that the new system (pro-type) was found usable and appreciated. With the implementation of this project, duplication of patient data would be eliminated, and the availability of a secured central database will encourage sharing of clinical data among relevant stakeholders in the health sector, thus informing timely decision-making.

References

[1] Nasiru Sani et al., "Assessment of Patient Healthcare Record Management Practices in Tertiary Health Institutions of Jigawa State, Nigeria," *International Journal of Advanced Technology in Engineering and Science*, vol. 4, no. 5, pp. 154-161, 2016. [Google Scholar] [Publisher Link]

[2] Abdel Nasser H. Zaied, Mohammed Elmogy, and Sahem Abd Elkader, "Electronic Health Records: Applications, Techniques and Challenges," *International Journal of Computer Applications*, vol. 119, no. 14, pp. 38-49, 2015. [Google Scholar] [Publisher Link]

[3] Olayiwola W. Bello et al., "Driving Electronic Health Record System Implementation in Nigeria: A Proposal," *1st International Conference of IEEE Nigeria Computer Chapter in Collaboration with Department of Computer Science*, pp. 200-204, 2016. [Google Scholar] [Publisher Link]

[4] Paul C. Tang, and Clement J. McDonald, *Electronic Health Record Systems*, Biomedical Informatics, Health Informatics, pp. 447-475, 2006. [CrossRef] [Google Scholar] [Publisher Link]

[5] Shadi Saleh et al., "Sijilli: A Scalable Model of Cloud –Based Electronic Health Records for Migrating Populations in Low Resource Settings," *Journal of Medical Internet Research*, vol. 22, no. 8, pp. 1-10, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[6] Global Hospital & Healthcare Management, Singapore's Journey to Build a National Electronic Health Record System, 2019. [Online]. Available: https://www.hhmglobal.com/knowledge-bank/articles/singapores-journey-to-build-a-national-electronic-health-record-system

[7] Arun Sam Singh Selwyn Jebaraj, "Implementing Electronic Health Records in New Zealand: A Critical Appraisal of Literature," *Health Informatics - An International Journal*, vol. 5, no. 4, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[8] Thebmjopinion, New German Digital Project Paves Way for Online Access to Personal Electronic health Records, 2021. [Online]. Available: https://blogs.bmj.com/bmj/2021/02/18/new-german-digital-project-paves-the-way-for-online-access-to-personal-electronic-health-records/

[9] Canada Health Infoway, Electronic Health Records, 2021.[Online]. Available: www.infoway-inforoute.ca/en/solutions/digital-health-foundation/electronic-health-records.

[10] The Commonwealth Fund, What is the Status of Electronic Health Record, 2021. [Online]. Available: https://www.commonwealth.org/what-status-electronic-health-records

[11] Olajide Ojo, Lagoon Hospital Implements Electronic Medical Records (EMR) – 1st in Nigeria, 2021. [Online]. Available: http://sqhn.org/wp-content/uploads/2013/04/007-EMR-Lagoon.pdf

[12] Igbo Gabriel Alobo et al., "Implementing Electronic Health System in Nigeria: Perspective Assessment in a Specialist Hospital," *African Health Science*, vol. 20, no. 2, pp. 948 -954, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[13] Bitrus Joseph et al., "Design and Implementation of a Secured Web-based Medical Record Management System: A Case Study of Federal University Wukari (FUW) Clinic," *International Journal of Computer Applications*, vol. 177, no. 41, pp. 27 -33, 2020. [Google Scholar] [Publisher Link]

[14] Victoria Samuel et al., "Design and Development of a Cloud-based Electronic Medical Records (EMR) System," *Data, Engineering and Applications*, pp. 25-31, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[15] Lizzy Oluwatoyin Ofusori et al., "Development of an Online Medical Record Management System," *ILorin Journal of Computer Science and Information Technology*, vol. 2, no. 1, pp. 29-45, 2017. [Google Scholar] [Publisher Link]

[16] Xiaolan He et al., "The Design of Electronic Medical Record for patients of Continuous Care," *Journal of Infection and Public Health*, vol. 14, pp. 117-122, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[17] Igbo G. Alobo et al., Implementing Electronic Health System in Nigeria: Perspective Assessment in a Specialist Hospital," *African Health Science*, vol. 20, no. 2, pp. 948 -954, 2020.

[18] Sarumi Jerry, and Idowu Sunday, "Implementation of an Efficient Digital Health Care Delivery System in Nigeria," *World Wide Journal of Multidisciplinary Research and Development*, vol. 2, no. 7, pp. 1-5, 2016. [Google Scholar] [Publisher Link]

[19] T. O. Oyegoke, R. N. Ikono, and H. A. Soriyan, "An Integrated Health Management System for National Health Insurance Scheme in Nigeria," *Journal of Emerging Trends in Computing and Information Sciences*, vol. 8, no. 1, pp. 30-40, 2017. [Google Scholar]

[20] Mohammed J. Ahmed, and Subhi R. M. Zeebaree, "Design and Implementation of an e-Hospital System at Kurdistan," *Kurdistan Journal of Applied Research*, vol. 2, no. 3, pp. 80-86, 2017. [CrossRef] [Google Scholar] [Publisher Link]