Evaluation of a Cloud Based Health Information System

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Abstract. In ensuring adequate antenatal and postnatal care which has been a major challenge in Africa and indeed Nigeria, there has been a need to evaluate and profound a comprehensive Health Information System (HIS) required for reducing Maternal Mortality Ratio (MMR) in the continent of Africa. There is a need for promptness and efficient healthcare for mothers to stem infant mortality ratios while giving the mothers a chance to life in difficult circumstances during child delivery. In some health care facilities in Nigeria the presence of HIS is obvious but it has not fully achieved the aim by which it was implemented due to lack of evaluation of the application. Hence this presentation tends to evaluate a usability of Health Information System using Cloud Platform for Antenatal and Postnatal Clinic in Nigeria to assess its suitability and sustainability in healthcare services towards improving maternal health. In the usability evaluation of the cloud based HIS, some factors were considered. These factors include: How simple it is to navigating the HIS. How simple users understand and use the HIS. How easy is it for users to reuse the HIS after a period of non-usage. If the HIS features are well structured. How easy is it for a user to use the application to satisfaction within a short period. Similarity of the layout when navigating different pages and functions on the HIS. Satisfaction of the users of HIS on its basic features and prompt error messages as required during usage. The extents to which the HIS links are been descriptive and self-informing.

Keywords: Antenatal · Postnatal · Health Information System
Cloud computing

1 Introduction

Evaluation needs to be conducted on a completed application to check if the application meets the need for which it was deployed. Evaluation can be conducted on criteria based approach or tutorial-based approach. The criteria-based approach gives a measure of products quality in terms of its sustainability, maintainability, and usability. Tutorial-based approach provides a pragmatic evaluation of the usability of existing software to check for its adaptability to an existing requirement [1].

In ISO 9241-11 standard usability is defined in terms of effectiveness, efficiency and satisfaction in a particular context of use. The intention was to emphasize that usability is an outcome of interaction rather than a property of a product [2]. Usability is being able to measure the extent to which a product can be used by the specified users to

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achieve specific goals for which system was created to ascertain its effectiveness, efficiency and satisfaction [3].

For the purpose of this presentation, a criteria-based approach was adopted to ascertain the usability or otherwise of the Cloud Based HIS in the Nigeria healthcare facility.

It is on record that Maternal Mortality Ratio (MMR) has been above 800 per 100,000 live births this is the condition over the span of last two decades in Nigeria [4, 5]. One of the difficulties in Nigeria and numerous Africa nations identifies with the quality and immediacy of antenatal and/or post-natal care given [5, 7]. For instance, results of a survey of 452 pregnant women accessing antenatal services in southwest Nigeria uncovered that the waiting time before antenatal consultation was 131.1 min, and around 66% of women were unhappy about their involvement in decision-making with respect to birth planning and postpartum contraception [5]. Although, general survey indicated irregularities in quality of services rendered [7]. However recent advancements in technology, notably HIS, have helped in the response to a large portion of these difficulties in health care, particularly in view of evidence from high income settings [8].

HIS application is in use in some healthcare facilities in Nigeria, but it has not been effective enough for record keeping and interoperability [9]. This has been so because of lack of evaluation of the existing HIS application.

The paper is organized as follows. In the next section, we will present the framework of the HIS. In Sect. 3 the usability factors of the Cloud Based HIS will be considered. While Sect. 4 will deal with the questionnaire which is divided into two sections: The first section shows the group of Participators (Health Care Practitioners and Patients) and their experience. The second section shows the Participators' perception of the HIS based on each of the usability factors earlier highlighted. Finally the conclusion drawn is in Sect. 5.

2 Framework of the HIS

Recent advancements in technology, notably HIS, have helped in the response to many of the challenges in health care, particularly in light of confirmation from high income settings [8]. Notwithstanding, numerous African nations do not have a sorted out HIS at all levels of care. In most hospitals with the exception of some faith-based ones, individual patients are saddled with the obligation of keeping health records in the form of booklets or vaccination cards [10]. Patient's information in most health facilities across Nigeria are stored manually [11]. The few facilities using electronic storage have the data exclusively residing with them and not available electronically to other health facilities within Nigeria [7]. This has prompted to endless loss of material assets and non-utilization of valuable manpower. Amid crises, medical histories are not promptly available, with this often resulting in wrong treatment plans [10]. Numerous researchers and health workers have thought widely on practical ways to enhance access to real time patient data at the point of care in Nigerian hospitals, particularly in the quest to encourage speedy analysis and treatment of cases [12]. Due to challenges highlighted, the HIS application has been developed. The System Architecture of the developed application is as represented in Fig. 1.

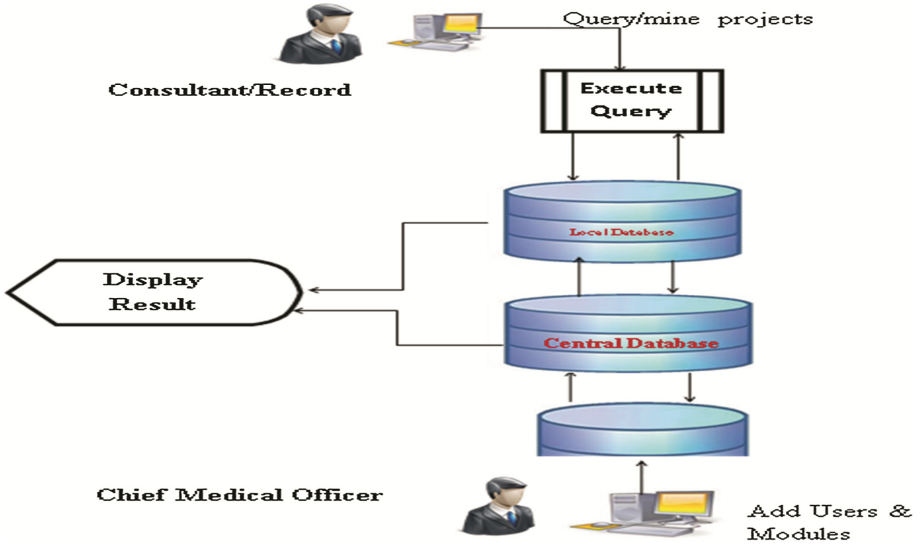

Fig. 1. System architecture of the antenatal/postnatal clinic system

In Fig. 1, the Consultant/Record Officer queries or adds data to the Local Database which inadvertently communicates with the Central Database as controlled by the Chief Medical Officer. An algorithm is used to categorize the data. After which the result is displayed. Also, the Administrator (Chief Medical Officer) is in charge of updating the Central Database but can delegate the responsibility. When data is sent to the database, it first passes through the staging area where it is cleaned before being stored in the data warehouse. Cleaning a data ensures that the data is in the right format before being sent to the database. This is to ensure data consistency.

3 Usability Attributes of the Cloud Based HIS

The major attributes of usability involves measuring the effectiveness of the interface between the users and the application. It means that the application is easier to learn and made use by the patients [13].

In order to evaluate the usability of the Cloud Based HIS, the following usability factors were considered [1, 2, 14, 15]:

3.1 Simplicity

This looks at the ease of users to and use the HIS. It also looks at how applicable the software is for its intended purpose. The application should be easily browsed without complications.

3.2 Completeness

It checks if the users are contented with the basic features of the HIS and errors messages been prompted when required.

3.3 Navigation

The HIS should have its most important features on the dashboard of the application for easy identification by users. This would make the application easy to navigate.

3.4 Satisfaction

It shows how satisfies the users are in the overall functions of the application and how easy it is for users to complete given task without having too much steps.

3.5 Hypertext Structure

The information about the HIS features must be structured appropriately to ensure that there are active links to various HIS functions and features needed by the users.

3.6 Memorability

When users return to the design page(s), they should be able to easily re-establish a proficient level of understanding after a period of considerable absence.

3.7 Self-evidence

The links to important information and functions are easily understood by the users, also these links are easily seen and very descriptive to the users.

3.8 Consistency

The design, layout and graphics of the application remains the same when navigating different pages on the application. This feature is to help the user understand the layout of the HIS faster.

4 Questionnaire

The questionnaire is divided into two sections. The first section shows the group of the Participators (Health Practitioners and Patients) and their experience. The second section shows the Participators' perception of the HIS based on each of the usability factors earlier highlighted. The Participators were asked to indicate their level of agreement with each question. Web enabled devices was used to administer the HIS to each Participators. The Participators were allowed to use the HIS without intervention of the

administrator excepts Participators needs to be reinstructed due to lack of concentration. The questionnaires were administered immediately after each task to improve the accuracy. All data were collected using a five point scale from "1", as "Strongly Disagree" to "5" as "Strongly Agree".

4.1 Participators

HIS is limited in scope to health care facilities, practitioners and patients. In this case, the healthcare facility within Covenant University, known as Covenant University Medical Center. 49 persons participated in the usability study of this work. This number is prescribed as required for such study [3, 16]. The Participators comprise of health practitioners and patients in Nigeria.

4.2 Data Analysis

The statistics showing the percentage of Participators in the use of computer software is given in Table 1. It reveals that the computer software is more engaged by health practitioners than the patients due to the functionality of the applications which is more tuned to the health care practitioners.

Table 1. Skill of Participators in the use of software

	No of participators	Health practitioner	Patients
Participators type	49	79.59%	20.41%

By interpretation, not all of the respondents are experts in the use of modern technology (Table 2).

Table 2. Shows different levels of computer literacy that Participators occupy.

	No of participators	Novice	Average	Good	Expert
Computer literacy	49	18%	32.65%	30.61%	18.37%

In addition, most of the respondents use a laptop to enhance their work (Tables 3 and 4).

Table 3. Devices used to access the HIS

	No of participators	Laptop	Desktop	Mobile device
Devices used	49	44.9%	36.73%	18.37%

Table 4. Shows the different Tasks carried out on the HIS.

	No of participators	Patients registration	Seminar attendant	Appointment booking	Reports generation	Doctors attending to patients
Task carried out	49	40.82%	12.24%	30.61%	100%	20.41%

4.3 Statistical Package for Social Sciences (SPSS)

For all the Participators, an overall score was computed for each of the usability dimension by averaging all the ratings on the questionnaire that was used. The Statistical Package for Social Sciences (SPSS) was used to generate the frequency distribution, mean and standard deviations and all the relevant charts for all the ratings (Table 5).

Table 5. Descriptive statistical analysis of questionnaire data

Usability attributes	Mean rating	Standard deviation	Variance
Simplicity	4.20	0.54	0.30
Completeness	4.09	0.49	0.24
Navigation	4.20	0.53	0.28
Satisfaction	4.03	0.73	0.54
Hypertext structure	4.16	0.52	0.28
Memorability	4.20	0.53	0.28
Self-evidence	4.20	0.53	0.28
Completeness	4.09	0.49	0.24

4.4 Reliability Test

The reliability estimates have been calculated from the data bank. The reliability and convergent validity by Cronbach's alpha estimate produced a result of 0.738 which is above 0.7 recommended [17]. This is an indication of the questionnaire's reliability. The maximum definition of Cronbach's Alpha coefficient theoretical is 1.0. The reliability statistics and the Cronbach's alpha value are shown in Tables 6 and 7 respectively.

4.5 Reliability Statistics

Table 6. SPSS test cases

	N	%
Valid	49	100
Excluded(a)	0	0
Total	49	49

Table 7. Cronbach's alpha

Cronbach's alpha	N of items
.738	8

4.6 Discussion

The score of the usability attributes as gathered from the respondents is talked about as follows:

4.6.1 Simplicity

The mean rating for "simplicity" was 4.03. This demonstrates the users found the HIS simple to utilize and get it. The frequency graph is as shown in Fig. 2.

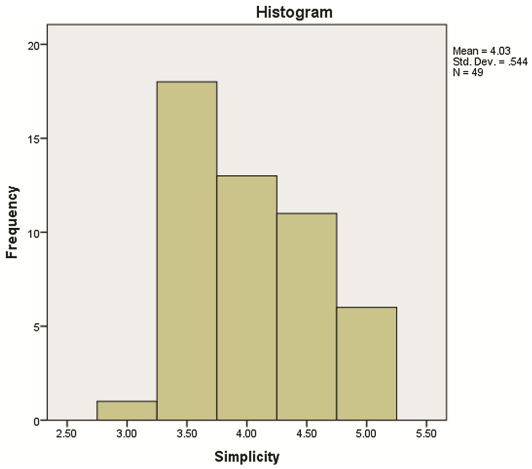

Fig. 2. Simplicity analysis

4.6.2 Completeness

The mean rating for "Completeness" was 4.09. This shows most of the users were happy with the fundamental features of the HIS. This is shown in Fig. 3.

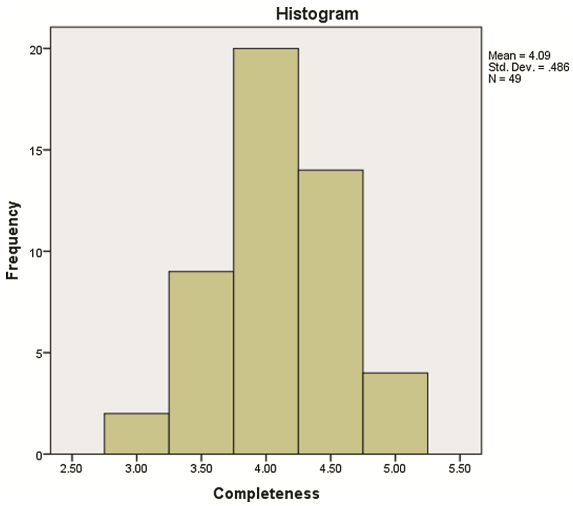

Fig. 3. Completeness analysis

4.6.3 Navigation

The rating for "Navigation" was 4.20 which shoes that, most of the users did not have challenges with navigating the HIS. This is shown in Fig. 4.

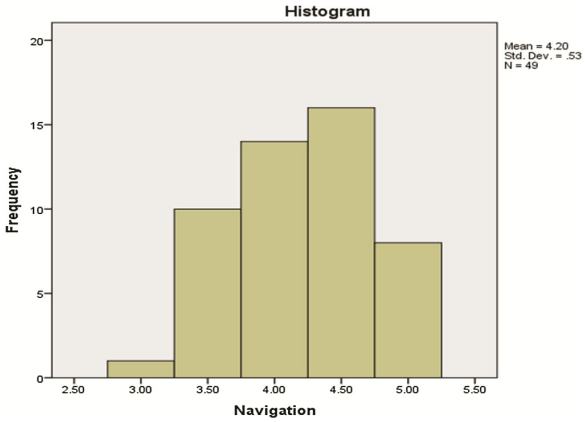

Fig. 4. Navigation analysis

4.6.4 Satisfaction

Most of the respondents were of the opinion that the HIS required few steps to complete any task thereby saving time. The mean rating was 4.03 and this is shown in Fig. 5.

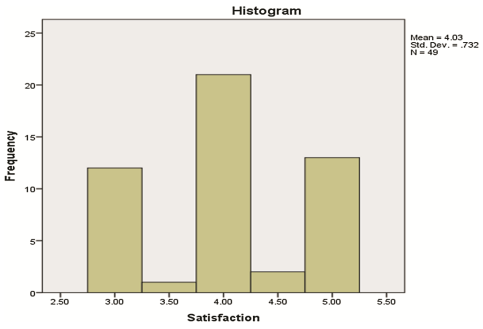

Fig. 5. Satisfaction analysis

The mean rating was 4.03 and most of the users were of the supposition that the HIS required few stages to finish any errand consequently saving time. This is appeared in Fig. 5.

4.6.5 Hypertext Structure

The mean rating of 4.16 for "Hypertext Structure" demonstrates that the vast majority of the users observed the HIS to be well organized and that there were dynamic connections to the different HIS capacities and components. This is shown in Fig. 6.

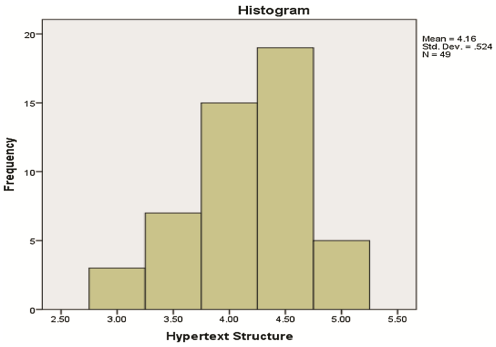

Fig. 6. Hypertext structure analysis

4.6.6 Memorability

Memorability is a property that could be impacted by the recurrence of visits to the HIS. It was measured by requesting that the users return to the HIS and attempt to review how to play out the fundamental tasks in the HIS following a time of 7 days. Its mean rating of 4.20 is appeared in Fig. 7.

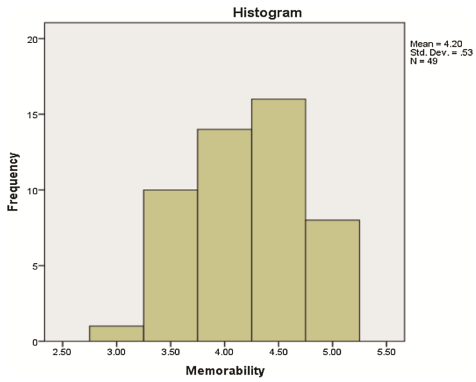

Fig. 7. Memorability analysis

4.6.7 Self-evidence

This demonstrates the HIS was found to contain tabs and connections to essential functions. Such tabs, buttons and interfaces on the HIS were self educating. This is appeared in Fig. 8 with a mean rating of 4.20.

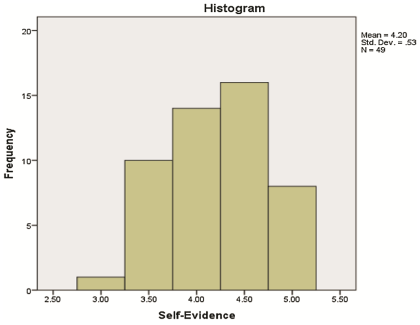

Fig. 8. Self evidence analysis

4.6.8 Consistency

Some of the users were of the conclusion that the HIS had a decent format that was reliable as they explored from one page to the next. The mean rating is given as 4.16. This is as appeared in Fig. 9.

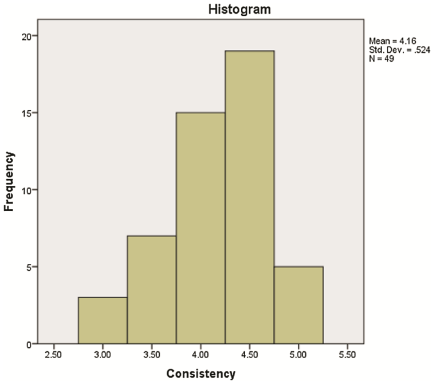

Fig. 9. Consistency analysis

Numerous usability studies suggest that system with "Good Usability" should have a mean rating of 4 on a 1–5 scale and 5.6 on a 1–7 scale [17]. We adopted the approach of a 1–5 scale, and conclude that the HIS had a "Good Usability" on mobile devices based on the following mean ratings of the given usability attributes, shown in Table 8.

Table 8. Usability attribute ratings

Usability attributes	Mean rating
Simplicity	4.20
Completeness	4.09
Navigation	4.20
Satisfaction	4.03
Hypertext structure	4.16
Memorability	4.20
Self-evidence	4.20
Consistency	4.16

5 Conclusion

This research presentation tends to evaluate a Cloud Based Health Information System for Antenatal and Postnatal Clinic in Nigeria, assessing its suitability and sustainability in healthcare services towards improving maternal health in Nigeria and Africa as a whole. It also highlights the importance of a detailed and secured health information system as a foundation to addressing perennial maternal health issues in Nigeria and many African countries. Hence, this research has implemented key concepts such as web services for easy integration, programing Radio-frequency identification (RFID) cards for identification and easy retrieval of patients' records, authentication of patient's records through biometric devices in other to ensure a secured system free from external factors. The unique advantage of this evaluated Cloud Based HIS is its adaptability as a unique software able to integrate seamlessly into an existing e-solutions. Working as software may also help it in supporting primary health care centers that might not be able to afford paying for a fully developed application. This research is not without foreseeable limitation, notably the unavailability of adequate computer systems, occasional power outages, inadequate servers and lack of systems connectivity in many local hospitals. However, with proper implementation plans, research inputs, technical support, sensitization, availability of funds, and government support, the overall goal of improving maternal health may still be within achievable limits.

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