



## Mobile Devices Enable Antenatal Care in Remote Areas of Nigeria

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### Authors' contributions

This work was carried out in collaboration among all the authors. Author BS supervised the study, performed the testing and corrected the manuscript. Author AMU developed and implemented the program, performed the system analysis, designed and wrote the first draft of the manuscript. Author MGA clearly explained the models into a program and tested the data within the program. Author BYZ managed the literature searches and provided all security flows in the program. Author BOL also managed the literature searches, interviewed the medical personnel in Federal Teaching Hospital, Gombe and served as the key person in system analysis. All authors read and approved the final manuscript.

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## Abstract

Nigeria is among the developing countries in the world with almost 60% of its population residing in remote areas where health care facilities are insufficient. The latest advancements in the field of computing and information technology especially mobile devices provide a significant opportunity to the rising countries to enlarge a health infrastructure that addresses the needs of the rural population. In this paper, we implement our model for Online Antenatal Consultation System Based on UML and Web Engineering Approach using Dreamweaver Cascading style 6 (CS6) as the front end while PHP serve as the scripting language, while using Cross-platform Apache HTTP Server MySql PHP Perl (XAMPP) server and MySql as the backend. Skype technology was embedded in the application to provide video and voice interaction between expert physician and the nurses in the rural areas as well as the pregnant women in the cities. The aim is to provide a cost efficient and effective antenatal care to the patients residing in the remote areas of Nigeria. In scrupulous, we have at first selected the domain of antenatal care because of disturbing mother mortality rate of Nigeria.

*Keywords: Antenatal care; online antenatal consultation system; mobile device.*

## 1 Introduction

Available evidence indicates that Africa accounts for the highest burden of mortality among women and children in the world, with Nigeria being the second in the world after Indian [1,2,3,4].

Pregnant women are suffering in the normal system of antenatal system in Nigeria right from the prenatal. These factors contribute to the increase in the maternal mortality, infant mortality and under-five child mortality. The persistent of high rate of maternal and child mortality in the country negates the achievement of the 4<sup>th</sup> and 5<sup>th</sup> Millennium Development Goals (MDGs). Nigeria, which constitutes just 1% of the world's population, accounts for 10% of the world's maternal and under-5 mortality rates [5]. This unhealthy trend has become a matter of great concern, calling for concerted approach for all and sundry [6,4].

Pregnant women in the rural areas where the maternal and infant mortality is high don't have access to expert physicians to take good care of them and they have to take their pregnant women to the cities during labor, the expert physicians mostly stay in the cities only few nurses and other health workers stay in the rural areas.

In addition, nurses at their station sometimes find it difficult to handle complicated cases of labor and delivery. They need assistance of online physicians at a spot to save life of child and mother but generally not available.

Therefore, there is need for effective system that will provide online antenatal services to both pregnant women in urban and rural areas in a cost effective manner in order to drastically reduce the rate of maternal mortality in Nigeria [1,7,8].

The research aim at implementation of the models designed for the Online Antenatal Consultation System by [1]. Using Unified Modeling Language (UML) Web Engineering Approach.

In the related work reviewed so far, it has been found that such an Online Antenatal Consultation System has not been implemented using web engineering approach. In this case, system requirement may not be well captured. Also the fact that most Nigerians are used to web pages such as browsing, checking results, sending mails, online registration and e-commerce among others therefore using web pages for antenatal consultation becomes very relevant. In addition, consider the statistics of maternal and infant mortality rate in Nigerian and the cost effective OACS to be developed, we therefore, notice that this research is a step forward towards saving the life of mother and child especially in rural areas where cases of maternal and infant mortality is prevalent.

## 2 Related Literature

Telemedicine is the use of telecommunication technology for medical diagnoses and patient care. From its beginning telemedicine has been used in a variety of health care fields although wide spread interest among health care providers and now become apparent with the development of more sophisticated technology. The objectives were to assess the effect of telemedicine as an alternative to face-to-face patient care. Seven trials involving more than 800 people were included as concerned with telemedicine in the emergency department, video consultation between primary health care and hospital out patients department, the rest were concerned with the provision of home care or outpatient self-monitoring of chronic disease. The authors concluded that establishing system for patient care using telecommunication technologies is feasible, but there is little evidence of clinical benefit [9,7,10].

According to [11] In National Space Research and Development Agency of Nigeria (NASRDA) reported that the total economic cost for the year 2008 telemedicine was US\$ 180 billion and hence disaster remains potential threat to National Development. In the highlight for the need for telemedicine in Nigeria they stated that: -

- i. 70% occurs in rural settings.
- ii. Satellite communications prerequisite for emergency health care services (Telemedicine, Teleconsultation and Tlediagnosis) and
- iii. Telemedicine (E-Health): is an integrated system of health-care delivery that employs telecommunications and computer technology as substitute for face-to-face contact between health service provider and client.

Benefits of telemedicine in Nigeria are:

(i) Support health-care delivery in distance remote sites and villages (ii) Connect the primary care physicians, providers, specialists and patients (iii) Cheap health care delivery. The implementation of pilot scheme in Nigeria can link to overseas hospital for second opinion and referral services using NIGCOMSAT-1. The integration of the sub network comprises eight remote terminals and one mobile unit. The remote terminal of the project include: Bayelsa, BirninKebbi, Gombe, Ibadan, Owerri, Owo, Maiduguri and Markudi while the mobile bus is equipped with basic diagnosis such as cameras (which include general examination camera and image illumination system) and diagnostic scopes (which also include electronic stethoscope, Ear, Nose & Throat scope, ophthalmoscope and Derma scope). Medical services provided include: -Special referral services, Patients remote consultation, Remote patients monitoring, Medical education and Medical health records and information databank

The challenges faced are de-orbiting of NIGCOMSAT-1, funding and institutional even although the pilot project was a success then. While telemedicine has a very strong role to play in advancing health care in Nigeria, we may need to prioritize properly in its diffusion process [12].

Research that is closed to this is the one that determines the complexities in fetal monitoring of high-risk pregnancy, using electronic patient record and birth alarm. The solutions for long-term fetal monitoring are necessary when a high-risk pregnancy is assumed. It includes different levels of complexity and technological challenges, depending on the supplied information: images, videos, signals, (multimedia) Electronic Patient Records (EPR). The lowest complexity is given when only alarm systems are implemented [13,14]. This kind of systems usually provides a button that allows contacting a call center of a medical system serving the alarm situations. The next level of complexity appears in the store-and-forward systems; here the relevant data (signals, images and processed information) are stored and forwarded for a medical examination. These systems are cheaper, due to the asynchronous transmission, and they are widely used when the real-time monitoring is not demanded [15,16].

Another research that focuses on using telemedicine equipment and video conferencing using both wired and wireless area network (WAN) shows that the highest complexity is involved by real-time applications,

based on the synchronous transmission. For these telemedicine systems, the use of some kind of video-conferencing equipment is common [17]. The prenatal telemedicine system includes at least a base unit (doctor's unit) and a portable patient unit that communicates with each other through a wired/wireless wide area network (WAN). The traditional wired telemedicine networks, based on the Plain Old Telephony Systems (POTS) and the Integrated Services Digital Network (ISDN), and wired LAN, are lately replaced by the wireless networks [18,17] and its recently improved version, the cognitive radio approach [13,19,20] using mobile phone (GPRS, GSM, G3) [21], or Satellite technology [22].

Research by [23] based on advancements in Information and Communication Technology; enables specialist doctors to provide remote health care to the patients. Automation of monitoring and instantaneous medical analysis and feedback certainly improves the quality of health care. The system is an important step towards providing better health care to population in rural areas where health facilities are virtually either non-existent or insufficient. The system has comprehensive development and evaluation strategy and it is intended to augment the existing healthcare infrastructure targeted at reducing MMR and IMR. It also helps in creating the wave of interest in Research & Development in the field of Bio-Engineering in Pakistan. The overall architecture of the system consists of wearable medical sensor modules, a Data Gathering Module (DGM), a Portable Digital Assistance PDA, a Remote Server providing Clinical Decision Support System (CDSS) and Electronic Medical Record (EMR) management, and any web enabled remote terminal (e.g. doctor's laptop) which could be used to access services provided by the web-server.

Another similar research that uses The Mobile Patient has identified that remote patient monitoring consists of three core components: (1) sensor nodes that monitor the vital signs of the patients, (2), patient level node (usually PDA) for transmission of data to a root node and (3) the root node (server) for gathering information from patient level nodes and maintaining the records. These ideas have been inspired by the research reported in [24,21,25]. The heart of the system is a server in which electronic medical record or central patient database maintains patient's general information and medical history [26,27,24,28,7,8].

Similar research on store and forward Tele consultation using video conferencing technology has been done by Taxilla and Gilgit. The methodology used in Taxilla project was "Store and Forward Tele consultation" through email, while in Gilgit project voice chat was also included. These works showed that telemedicine can be used successfully to provide specialist care in remote areas. Telemedicine provides the inexpensive way of delivering specialist healthcare facilities to the large population residing in rural areas. However, the people still need to travel to nearest health centers where the facility of video conferencing was made available [29].

## **2.1 Antenatal in Nigeria**

The term antenatal refers to the diagnosis of birth defect that is before birth or during pregnancy. Prenatal is the care performed to the pregnant women before birth and post natal is the care giving to the infant immediately after birth [30,4].

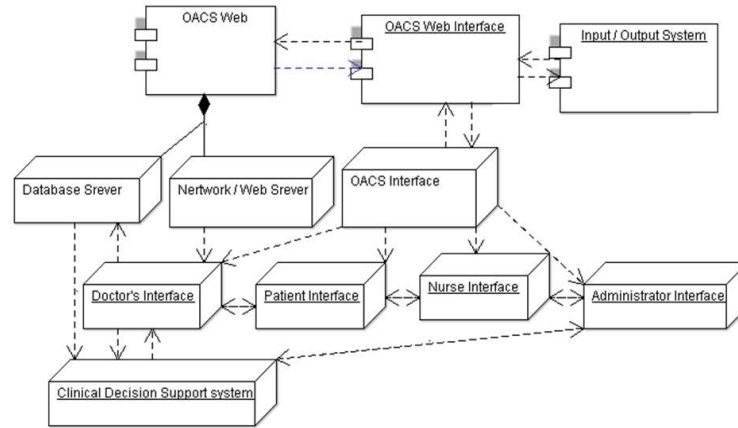
Antenatal Care (ANC) means "care before birth", and includes education, counseling, screening and treatment to monitor and to promote the well-being of the mother and fetus. The current challenge is to find out which type of care and in what quantity is considered sufficient to ensure good quality of care for low-risk pregnant women. Only interventions of proven effectiveness, for which benefits largely overcome possible harms, and those acceptable to pregnant women and their families, should be offered [6,4].

Antenatal care is the care that a woman receives during pregnancy. It helps to ensure healthy outcomes for women and new born [31]. In the developing world nearly 70% of pregnant women have at least one antenatal care visit, and the majority of women presenting for any ANC have at least four visits. All age groups show similar rates of four or more visits. Rural and uneducated women are least likely to receive ANC. Women reporting at least four ANC visits are on average 3.3 times more likely than other women to give birth with a skilled provider. In Nigeria the situation is worst due to population of the pregnant rural women [31,4].

### 3 Methodology

#### 3.1 System design

The system design is concerned with the strategies for building the system. This include the hardware/software platform on which the system will run, the persistent data management strategy, the global control flow, the access control policy and the handling of boundary conditions. The result of the system design is a clear description of these strategies. Such as subsystem decomposition and a deployment diagram representing the hardware/software mapping of the system as presented in Fig. 1 below:



**Fig. 1. Deployment diagram representing the system design**

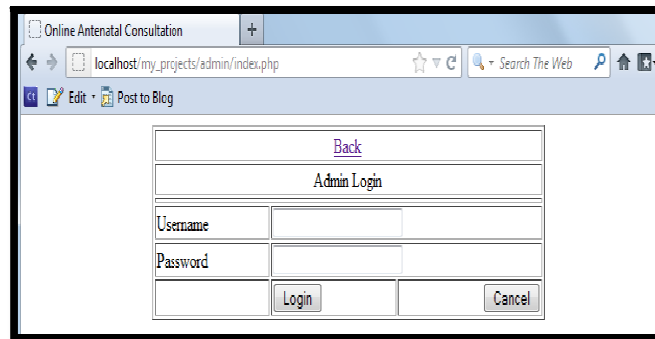
#### 3.2 Interface design

The interface designed used for the implementation of the Online Antenatal Consultation System (OACS) is either input interface or output interface as shown below:

##### 3.2.1 Input interface design

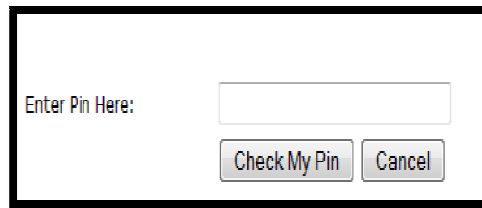
Some of the input interfaces design that implements the OACS is shown below:

1. Admin Index page: This is the page where the administrator of the system can login with a valid username and password as shown in Fig. 2 below:



**Fig. 2. Admin login**

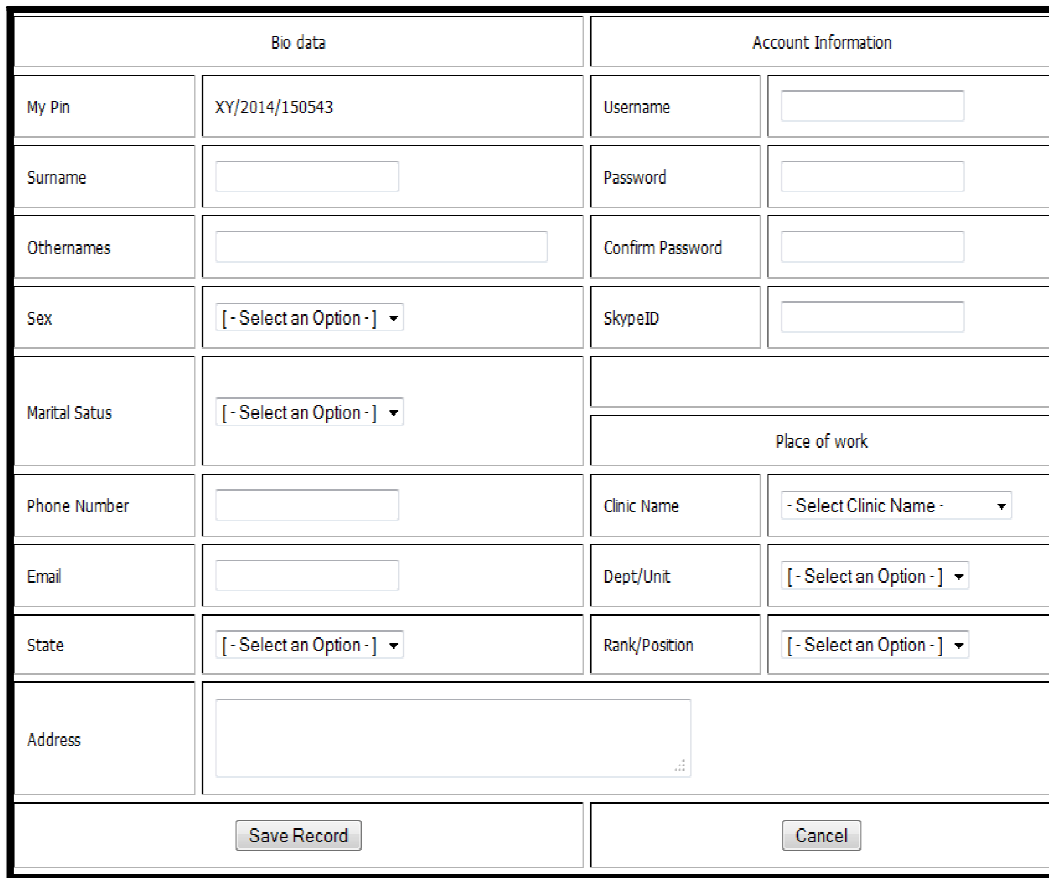
2. Pin Authentication Page: This page is where the doctor's and nurse's use to enter the pin collected from the administrator for their registration as indicated in Fig. 3 below:



The image shows a web form for pin authentication. It has a title bar at the top. Below the title bar, there is a label "Enter Pin Here:" followed by a text input field. Below the input field, there are two buttons: "Check My Pin" and "Cancel".

**Fig. 3. Pin authentication page**

3. Registration Page: Once the OACS recognizes the pin in Fig. 3 is valid after clicking Check My Pin button. Then it will open a registration page, for the doctor or nurse as shown in Fig. 4 below:



The image shows a complex registration form with multiple sections. The form is divided into two main columns: "Bio data" and "Account Information".

Bio data		Account Information	
My Pin	XY/2014/150543	Username	<input type="text"/>
Surname	<input type="text"/>	Password	<input type="text"/>
Othernames	<input type="text"/>	Confirm Password	<input type="text"/>
Sex	[ - Select an Option - ] ▼	SkypeID	<input type="text"/>
Marital Satus	[ - Select an Option - ] ▼	Place of work	
Phone Number	<input type="text"/>	Clinic Name	[ - Select Clinic Name - ] ▼
Email	<input type="text"/>	Dept/Unit	[ - Select an Option - ] ▼
State	[ - Select an Option - ] ▼	Rank/Position	[ - Select an Option - ] ▼
Address	<input type="text"/>		
Save Record		Cancel	

**Fig. 4. Registration page**

4. Patient Registration Page: The pregnant women need to register with a pin similar to that of Fig. 3. once the pin is valid the OACS will open the patient registration page as shown in Fig. 5.

Patient's Registration Form			
Bio data		Account Information	
My Pin	XY/2014/150543	Username	<input type="text"/>
Surname	<input type="text"/>	Password	<input type="text"/>
Othernames	<input type="text"/>	Confirm Password	<input type="text"/>
Year Of Birth	<input type="text"/>	SkypeID	<input type="text"/>
Marital Satus	[ - Select an Option - ]	Husband data and Clinic	
Phone Number	<input type="text"/>		
Email	<input type="text"/>	Nearest Clinic	- Select Clinic Name -
State	[ - Select an Option - ]	Husband Name	<input type="text"/>
Address	<input type="text"/>		
Save Record		Cancel	

**Fig. 5. Patient registration page**

5. Education Profile Page: This is the page where the Doctor's and the Nurse's add and update their educational qualification as shown in Fig. 6 below:

Add Educational Profile					
Name of School Attended/Country:	From:	To:	Certificate Obtain:		
<input type="text"/>	2012	2012	<input type="text"/>		
		<input type="button" value="Add Profile"/> <input type="button" value="Cancel"/>			
Note: Please add one record at a time					
Staff Educational Profile					
S/N	Name of School Attended	From:	To:	Certificate Obtain:	Delete


**Fig. 6. Education profile page**

### 3.2.2 Output interface design

The output interfaces produce the information entered from the input design page, which can be a web page containing all the relevant information. Some of the output interfaces design that implements the OACS is shown below:

1. View Education Profile Page: This page retrieve the information saved on Fig. 4 to enable visitors to see doctors and nurses profile as shown in Fig. 7 below:

**NURSES AND COMMUNITY HEALTH WORKERS PROFILE**



Name: ~~XXXXXXXXXX~~ HADIZA Sambo

Sex: Female

Marital Status: Married

Phone Number: ~~XXXXXXXXXX~~ 47

Email: ~~XXXXXXXXXX~~@gmail.com

Skype Id: umm4real

State of Origin: Gombe

Clinic Name: Gombe Specialist Hospital

Department: Nursing

Rank: Senior Nurse

Home Address: Madina Quaters Gombe

Educational History				
S/N	Name of School Attended/Country:	From:	To:	Certificates Obtain:
1	Abubakar Tafawa Balewa University, Bauchi	2012	2012	B Sc Nursing

**Fig. 7. View education profile page**

2. Edit Patient Record Page: This is the page where the pregnant woman can edit and update her record. Similar, pages also exist for both doctors and nurses to edit their record. The page is shown in Fig. 8 below:



The screenshot displays a web form titled "Patient's Update Registration Form". It is divided into two main sections: "Bio data" and "Account Information".

**Bio data section:**

- Pin Used:** XY/2013/377502
- Surname:** Aisha
- Othernames:** Ali Muhammad
- Sex:** Female
- Marital Satus:** Married (dropdown menu)
- Phone Number:** 2147483647
- Email:** XXXXXX@adiza@yahoo.com
- State:** Ondo (dropdown menu)
- Address:** Samusa Quateza

**Account Information section:**

- Username:** aisha
- Password:** (empty field)
- Confirm Password:** (empty field)
- SkypeID:** XXXXX@skype

**Husband Details and Clinic section:**

- Nearest Clinic:** Specialist
- Husband Name:** Ali Muhammad
- Husband Phone No:** XXXX255

At the bottom of the form, there are two buttons: "Update Record" and "Cancel".

Fig. 8. Edit patient record page

### 3.3 File/database design

The database was developed using MySQL found in XAMPP server, v.3.1.0 3.1.0 which is an open source compatible with php. The name of the database is my\_projects and it contains fifteen (15) tables:

- i. **Admin:** This table contains the username and password of the administrators of the OACS.
- ii. **Clinic:** This table contains the records of the Clinics, Specialist Hospitals, Maternities, Medical Centers and Teaching Hospitals use by the OACS.
- iii. **Doctor\_education:** This table has all the necessary educational data for the doctors. Also, the details of all the schools attended, duration and the certificates obtained.
- iv. **Doctor\_picture:** This table contains the links to all medical doctors' pictures. The pictures uploaded during registration are saved in the table.
- v. **Messages:** This table contains the detailed of all information sent by the patients to the relevant doctors and the doctor response to the patient's query. In the same vein, it comprises the details of all conversation made by the nurse to the doctor and vice versa.
- vi. **Notice:** This table is used by the administrator of the OACS to post any new notice or information to the general public. Once if there is any new information it should be sent by the administrator which can be seen on the home page of any visitor.
- vii. **Nurse\_education:** This table hosts all the necessary educational data for each nurse and other community health workers. The details of the schools attended, duration and the certificates obtained.
- viii. **Nurse\_picture:** This table contains the links to all nurses and community health workers picture. The pictures upload during registration are saved in this table.

- ix. **Patient\_picture:** This table contains the links to all pregnant women pictures. The pictures uploaded during patient's registration are saved in this table.
- x. **Pin:** This table is also used by the administrator of the OACS to create as many pins as possible. These pins are used when registering each actor of the OACS.
- xi. **Prescribed\_drugs:** This table contains the detailed of drugs prescribed by a doctor to a pregnant woman and date the prescription was made.
- xii. **Reg\_doctor:** This table contains all the doctor's bio data and their address, phone numbers, email address and skypeID etc
- xiii. **Reg\_nurse:** This table contains all the nurses and community health workers bio data and their address, phone numbers, email address and skypeID etc.
- xiv. **Reg\_patient:** This table contains all pregnant women's bio data and their address, phone numbers, husband phone numbers, skypeID etc
- xv. **Sliders:** This table is also used by the administrator of the OACS to create, modify, add and delete slides that are seen on the home page.

### 3.4 Program design

#### 3.4.1 Architectural model of the OACS

The basic model consists of an input module, a remote server providing Clinical Decision Support System (by the Doctor) and electronic medical record system that keeps history of all medical records for each patient, and any web-enabled remote terminal (such as Doctor's laptop or Mobile Device, Nurse laptop or Mobile Device and Administrator's laptop). This could be used to access services provided by the web-server using a multipurpose modem that can accept a 3G wireless network or any one that can suit the application. A projector will provide a team online consultation among doctor's in their station and nurses in both urban and rural areas.

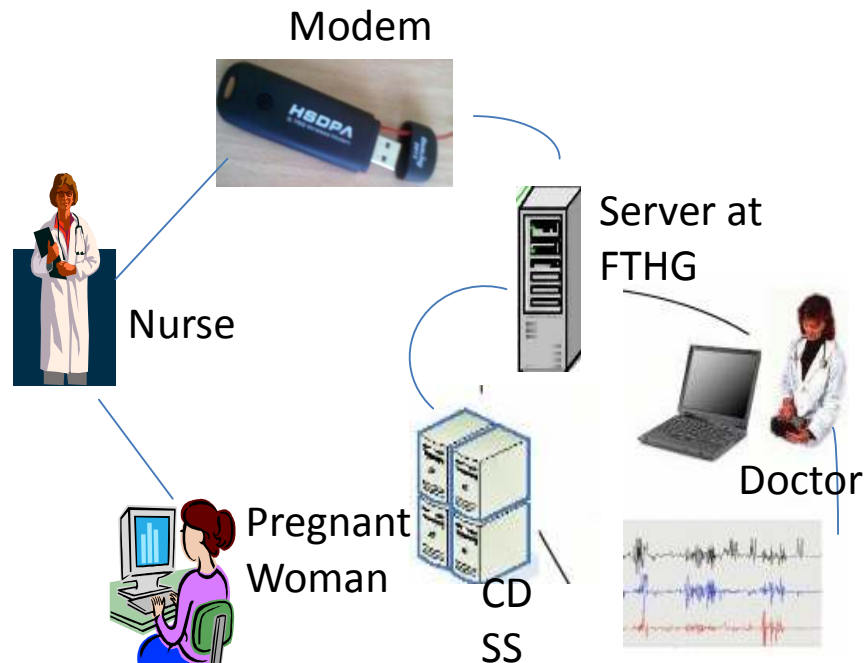


Fig. 9. Basic Architectural Model for OACS (Adapted from Muhammad et al, 2010)

### 3.4.2 Class based diagram

This consists of classes that are used in implementing the online antenatal consultation system as shown in Fig. 10 below:

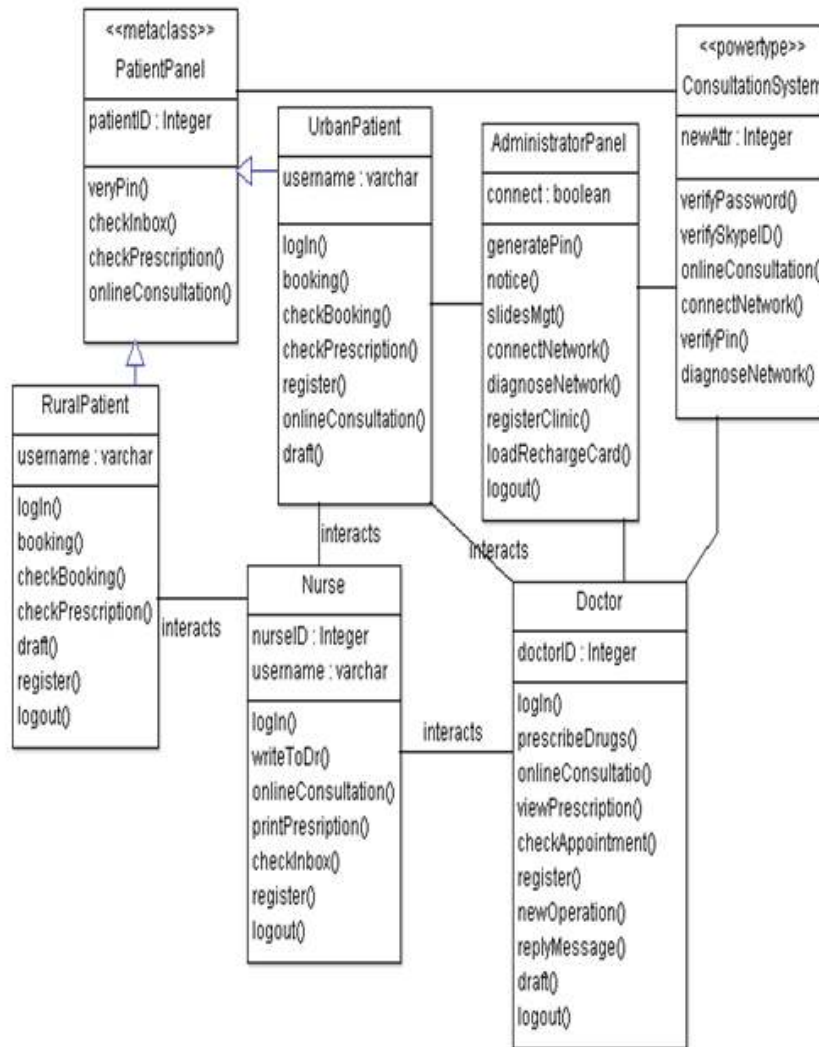


Fig. 10. Class based diagram

### 3.5 System requirement

The system can work on any of these devices: PC, Desktop, laptop, Palmtop and Mobile devices such as smart phones, tablets and Android gadgets. A web browser (such as Internet Explorer, Mozilla Firefox, Comet Bird, Opera, Google Chrome etc) is also needed for the successful running of the web pages, a Skype must be downloaded and installed on the system unless, if the system have Skype installed on it. A functional camera is needed to provide the video interaction. A projector will be used to project the video interaction among the expert physicians and the nurses in their station. Finally, a modem is needed in order to provide the internet connection on the laptop and the desktop.

## 4 Testing and Results

### 4.1 Testing

This focuses on completely testing the web application developed, to address issues before the system is revealed to public. This include testing the web user interface and ensuring that for any correct input it gives correct result (output) from the OACS. The system is tested at the point of implementation both unit testing and integrating test is adopted.

### 4.2 Home page

This serve as the home page of the system, users navigate from the home page to any location on the page as shown in Fig. 11 below:



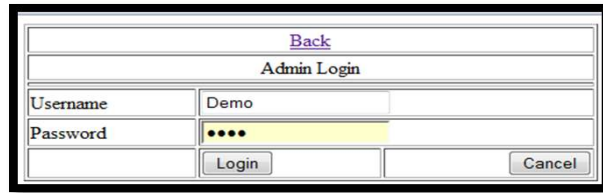
Fig. 11. Home page, for the OACS

### 4.3 Test cases

#### 4.3.1 Case 1: Administrator

This case present some of the functions perform by the administrator and in each case a result is obtain to check whether administrators' duties are done successfully.

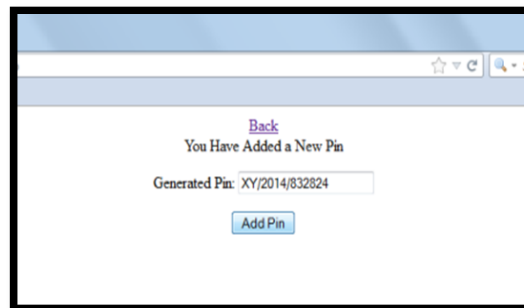
- a. **Administrator login:** This is the page where the administrator will login to the system, the administrator must login with a valid username and password for security checks otherwise the system cannot allow the administrator to login. The admin index is shown in Fig. 12



The screenshot shows an 'Admin Login' form. At the top is a 'Back' link. Below it is the title 'Admin Login'. There are two input fields: 'Username' with the value 'Demo' and 'Password' with masked characters '\*\*\*\*'. Below the password field is a 'Login' button. To the right of the 'Login' button is a 'Cancel' button.

**Fig. 12. Admin login page**

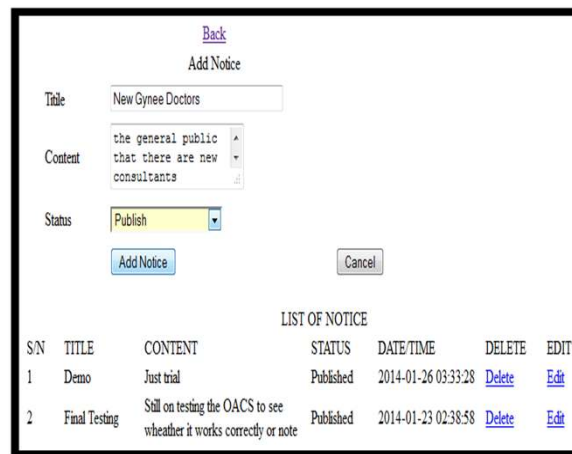
- b. **Add pin:** Is where the administrator will add pins to be used in registering any user as shown in Fig. 13 below



The screenshot shows a confirmation message 'You Have Added a New Pin' with a 'Back' link above it. Below the message is a text box displaying 'Generated Pin: XY/2014/832824'. At the bottom is an 'Add Pin' button.

**Fig. 13. Add pin**

- c. **Post Notice:** Is where the administrator can post any notice on the home page for any user to see, and also update and delete the posted notice. As indicated in Fig. 14.



The screenshot shows a 'Post Notice' form. At the top is a 'Back' link and the title 'Add Notice'. There are three input fields: 'Title' with the value 'New Gynee Doctors', 'Content' with the value 'the general public that there are new consultants', and 'Status' with a dropdown menu set to 'Publish'. Below the status dropdown are 'Add Notice' and 'Cancel' buttons. Below the form is a table titled 'LIST OF NOTICE'.

S/N	TITLE	CONTENT	STATUS	DATE/TIME	DELETE	EDIT
1	Demo	Just trial	Published	2014-01-26 03:33:28	<a href="#">Delete</a>	<a href="#">Edit</a>
2	Final Testing	Still on testing the OACS to see wheather it works correctly or not	Published	2014-01-23 02:38:58	<a href="#">Delete</a>	<a href="#">Edit</a>

**Fig. 14. Posting notice**

#### **4.3.2 Case 2: Login page**

This is the page where the doctor, nurse or patient will login with a valid username and password that they registered with. The web page is shown in Fig. 15. The user's need to register prior to login in the OACS, the detail of user's registration web pages is shown below:

**ON-LINE ANTENATAL CONSULTATION**

Home About Us Doctor Nurse Admin Login

Register Doctor  
Doctor's Login  
Register Nurse  
Nurse's Login  
Register Patient  
Patient's Login

**Doctor's Login**

Enter Username Here: FATI

Enter Password Here: [masked]

Login Cancel

**Notice Board**

New Gynnee Doctors	2014-02-04 02:04:18
Demo	2014-01-26 03:33:26
Final Testing	2014-01-23 02:38:56
Trial	2013-12-03 11:29:15

**Fig. 15. Doctor's login**

#### **4.3.3 Case 3: Complain/booking doctor**

This demonstrates a scenario where a registered patient or nurse will book an appointment with a registered doctor. In this scenario a registered patient is lodging her complain to doctor as shown in Fig. 16 below:

**Book Appointment or Send Complaint to a Doctor**

Patient's Username: aisha

Patient's Names: Ali Muhammad Aisha

Book Doctor: Ali Fatima

Complain Title: Sick

**Complaint Body**

Good day Doctor

I am writing to let you know that I did not sleep last night, I am suffering from headache, fever and vomiting. What can I do sir.

Thanks

Path: p » strong

Save as draft Send

**Fig. 16. Patient sending complain/booking to doctor**

#### 4.3.4 Case 4: Doctor's prescription to a patient

This scenario will show how booked doctors will prescribe drugs to the patient that booked against them. The detail is shown in Fig. 17 below:

Reply to a Patient

Prescription was Successfull!

Doctor's Username:

Doctor's Full Name:

Patient's Full Name:

Prescription:

**Purchase the following drugs:**  
**Cap Omeperazole 500Mg 25/5, Tab Paracetamol 500Mg 15/5, Cap Humairaquine 750Mg 25/4 and Tab Ciproxine 400Mg 15/3**

Path: p » strong

Fig. 17. Doctor's Prescription page

#### 4.3.5 Case 5: Online consultation

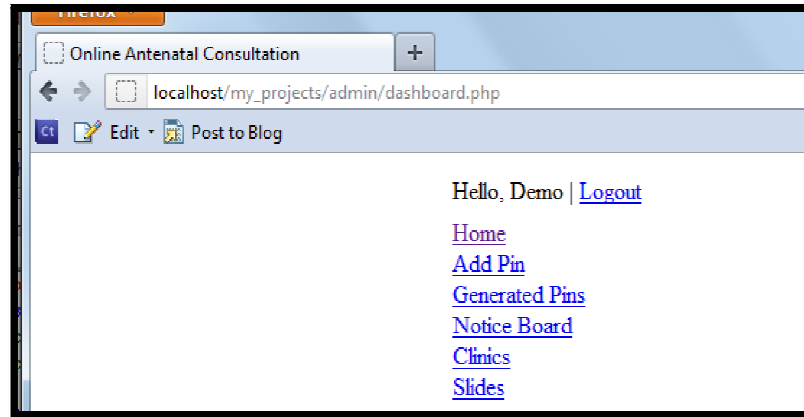
This provides an online consultation between doctors and nurses or patient. In each case a booking or complain should be sent to the doctor. After the doctor responds that the meeting should hold on a certain time, then the call to the doctors Skype will be made.

### 4.4 Results

#### 4.4.1 Results generated from OACS

##### 4.4.1.1 Case 1 (Administrator's) results

- a. **Admin login:** This will link the administrator to the admin dashboard with the administrator's username preceded with hello. This contains a link to all the activities the administrator is expected to perform once valid username and password is supply in Case1 a. Fig. 18. Shows the links of the Admin dashboard



**Fig. 18. Admin dashboard**

- b. **Generated pins:** Any pin generated by the administrator in Fig. 13 is saved in the pin table. The administrator can view the pins generated, if none then should generate more as shown in Fig. 19

[Back](#)

**Generated Pins Available in the Database**

S/N	Generated Pins	Date Generated
1	XY/2013/493255	2013-12-30
2	XY/2013/641479	2013-12-30
3	XY/2014/150543	2014-01-23
4	XY/2014/185424	2014-01-23
5	XY/2014/267425	2014-01-10

**Fig. 19. Generated Pins**

- c. **Notice Posted:** The result of the notice posted in Fig. 14 can appear in two places on the home page of the OACS for published notice and on the notice page where it can be edited or deleted as shown Fig. 20 below:

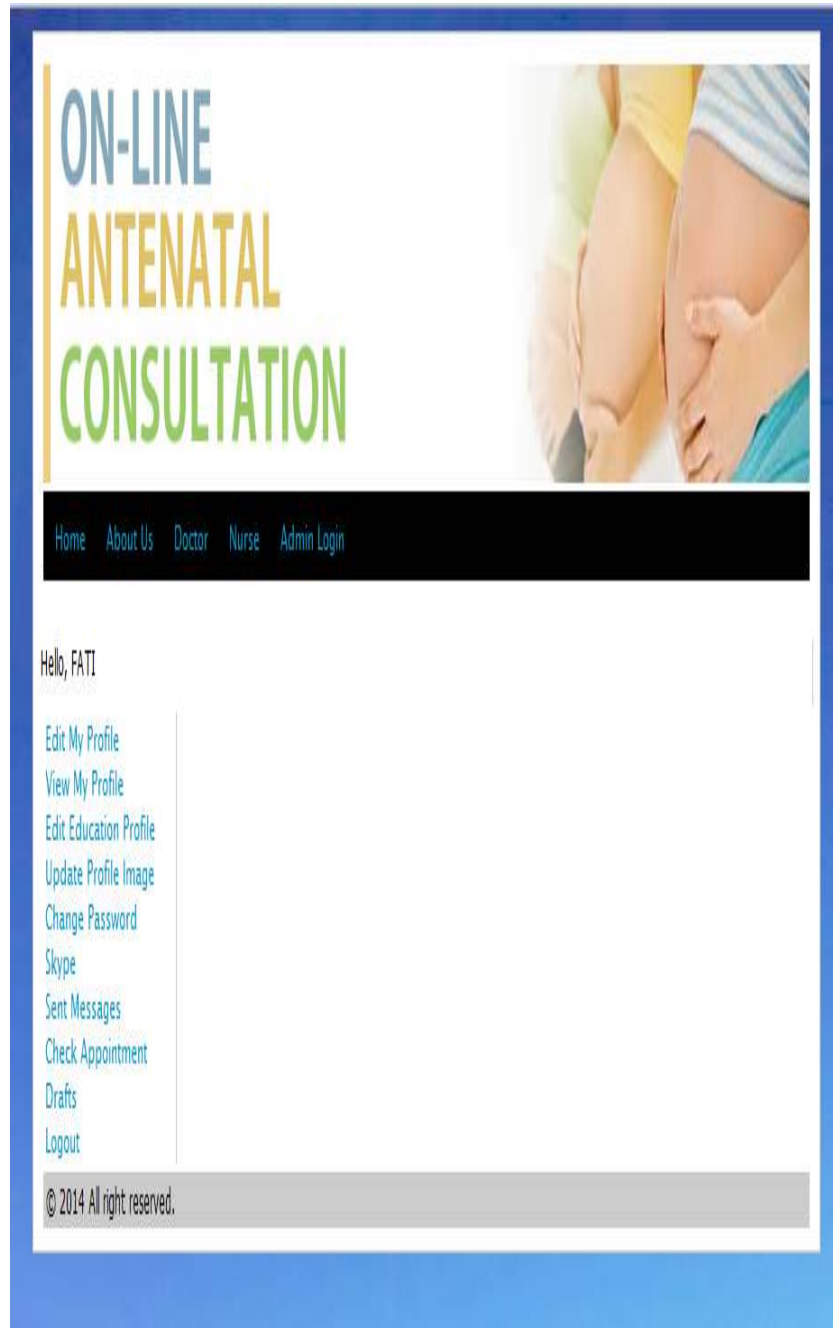
LIST OF NOTICE						
S/N	TITLE	CONTENT	STATUS	DATE/TIME	DELETE	EDIT
1	New Gynee Doctors	This is to inform the general public that there are new consultants doctors	Published	2014-02-04 02:04:18	<a href="#">Delete</a>	<a href="#">Edit</a>
2	Demo	Just trial	Published	2014-01-26 03:33:28	<a href="#">Delete</a>	<a href="#">Edit</a>
3	Final Testing	Still on testing the OACS to see wheather it works correctly or note	Published	2014-01-23 02:38:58	<a href="#">Delete</a>	<a href="#">Edit</a>

**Fig. 20. Posted Notice**



#### *4.4.1.2 Case 2 (login page) results*

Once correct username and password register with its type in Fig. 13, the dashboard page will be displayed. This contains a link to all the activities perform by the user, for the doctor that login the result of the login page is as shown in Fig. 21 below



**Fig. 21. Doctor's dashboard**

#### 4.4.1.3 Case 3 (complain/booking) results

The doctor can check the appointment made by the user in Case3 by clicking on the check appointment link on Fig. 21. This will show the result in Fig. 22 below, similarly, if a nurse book appointment the scenario is the same.

LIST OF INBOX MESSAGES					
S/N	FROM TO	SUBJECT	STATUS	DATE/TIME	DELETE
1	Ali Muhammad Aisha	<a href="#">Sick</a>	Received	2014-02-06 11:44:21	<a href="#">Delete</a>
2	Ali Muhammad Aisha	<a href="#">xczvcxzcvcxvzxcvcxvxz</a>	Received	2014-01-12 08:01:06	<a href="#">Delete</a>

**Fig. 22. Lists of inbox messages**

Once the doctor click on the subject the body of the message sent by the patient will be seen as shown in Fig. 23 below:

MAIL STATUS:	
SENDER'S NAME:	Ali Muhammad Aisha
SUBJECT:	Sick
DATE:	2014-02-06 11:44:21
Good day Doctor	
I am writing to let you know that I did not sleep last night, I am suffering from headache, fever and vomiting. What can I do sir.	
MAIL:	Thanks
	Aisha
<a href="#">Reply</a>   <a href="#">View Previous Patient Prescription</a>   <a href="#">Prescribe Drugs</a>	

**Fig. 23. Doctor's inbox messages**

Here, the doctor is having three options, to reply, view up to five previous prescriptions made to the patient and prescribed drugs, depending on the level of the sickness or pregnancy.

#### 4.4.1.4 Case 4 (patient checking prescribed drugs) results

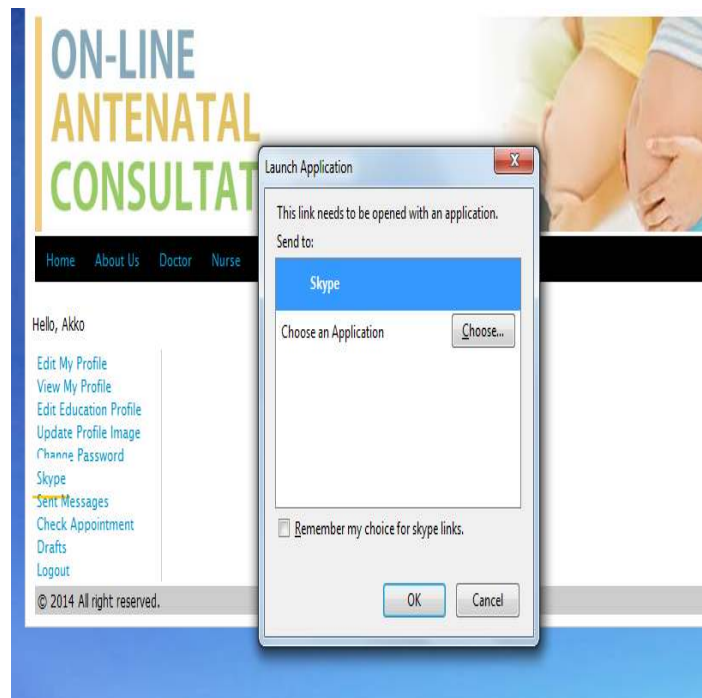
This is the result of Case3 where the patient can check the prescribed drugs sent by the doctor as shown in Fig. 24 below. The patient can print the drugs by clicking on the print link. Similarly the same pattern is follow to check reply made by the doctor.

Prescribed Drugs	
Patient Name:	Aisha Ali Muhammad
Age:	24
Address:	Bamusa Quaters
Date:	2014
<b>Aisha</b>	
Drugs:	<b>Purchase the following drugs:</b> <b>Cap Omeperazole 500Mg 25/5, Tab Paracetamol 500Mg 15/5, Cap Humairaquine 750Mg 25/4 and Tab Ciproxine 400Mg 15/3</b>
Doctor's Name:	Ali Fatima
Hospital:	Gombe Specialist Hospital
Rank:	Gynee Doctor
<a href="#">Print</a>   <a href="#">Back</a>	

**Fig. 24. Patient prescription page**

#### 4.4.1.5 Case 5 (online consultation) results

On clicking on the Skype link, an installed Skype program will open as shown in Fig. 25 below:



**Fig. 25. Opening Skype**

Then a call should be made to the doctor's Skype as demonstrated in Fig. 26 below:



**Fig. 26. Online Consultations with Skype**

## 5 Discussion of Results

The interfaces are checked separately to ensure that all bugs are removed, unit testing and integrating testing are done effectively. Some users were given to test run the web application; bugs found are resolved till no bug is found.

From the results obtained in all the cases, it's clearly show that for every correct input it produces the correct result as expected from the OACS. Where wrong input is given an appropriate message is displayed for the user.

The OACS is designed and implemented to work on desktop computers, laptops and mobile phones as suggested in [1] However, the modem to be used in providing internet connection may fail if poor network is detected from the network providers.

## 6 Conclusions

A web-based application for the targeted Online Antenatal Consultation System (OACS) was developed and fully tested. If the OACS is deployed and use effectively, it will help in reducing the problems of maternal mortality in Nigeria.

The related works reviewed in the literatures show that majority use ICT enabler to solve the patient's problems in the rural areas only, while this work incorporates both those in the rural areas and the cities as well.

Despites, NASRDA reports on telemedicine in the Nigerian context showing that it is facing challenges of de-orbiting of the NIGCOM SAT1, funding and institutional, which indicates clearly that the implementation of telemedicine is quite expensive. In this work only a modem, network provider, devices (such as a computer or mobile devices) and a good network is needed; no need for any satellite for its operation to take place.

The system developed is currently under thorough testing at the Federal Teaching Hospital, Gombe Nigeria. The results obtained should be analyze and compare to the normal antenatal care results obtained in [28,30] and other related works.

The architectures of the related works reviewed indicate, that either hand held device or desktop computer was used, not both. But in OACS introduced in this research both hand held devices and desktop computer can use it.

Finally, the related works reviewed vindicate that; they all used software engineering approach in their implementation and none of them developed a model prior to the implementation. Whereas, in this current research a model was developed and implemented using web engineering approach.

## **Consent**

It is not applicable.

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## **Competing Interests**

Authors have declared that no competing interests exist.

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