DESIGN AND IMPLEMENTATION OF A WEB BASED INFORMATION SYSTEM FOR NATIONAL HEALTH INSURANCE SCHEME USING THE OBJECT-RELATIONAL DATABASE APPROACH

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ABSTRACT

The design and implementation of a web-based administrative information system for National Health Insurance Scheme (NHIS) using its guidelines has been carried out. The system allows any NHIS-Registered patient to visit any registered provider anywhere in the country and be assigned to a doctor. To carry out the project we proposed a suitable architecture for the design of a model of object-relational database for it's implementation. The .NET framework has been explored for use in designing a web-based working prototype for the scheme with cold fusion mark-up language (cfml) using Dream Weaver platform; Backend is Access DBMS with ColdFusion web server acting as middle-tier.

KEYWORDS: Object-Relational, Mapping, Web-Based, Prototype, Coldfusion,

1.0   INTRODUCTION

In spite of the impact of relational databases over the last few decades databases of this kind have some limitations for supporting the data persistence required by present day applications. Owing to recent hardware improvements, more sophisticated applications have emerged such as CAD/CAM (computer-Aided Design/Computer Aided Manufacturing). CASE (Computer-Aided Software Engineering). GIS (Geographic Information System) etc. They may be characterized as consisting of complex objects with complex relationships.

Representing such objects and relationships in the relational model implies that the objects must be broken down into a large number of tuples. Thus, a considerable number of joins are necessary to retrieve an object and when tables are too deeply nested, performance is significantly reduced. A new generation of databases has appeared to solve these problems. The object-oriented database generation, which includes object-relational and object databases? This new technology is well suited for storing and retrieving complex data types and relationships, multimedia data, inheritance etc. Nonetheless, good technology is not enough to support complex objects and applications. It is necessary to define methodologies that guide designers in the object database design task, in the same way as has traditionally been done with relational database. In recent years some approaches to object-oriented database design have appeared.

Database technologies have found their applications in various fields of human endeavour. There is virtually no field that does not find the application of database technology relevant. The health industry is not left out.

The National health insurance scheme (NHIS) will enjoy great significance if its activities are done employing sophisticated health applications enabled by a database technology capable of handling and sharing demographic information such as patients name and address; and information about hospitals and doctors. This application will cover different areas like immunizations or blood screening for patients.

Many health-related processes stand to be reshaped by these computer-enabled technologies. The ease, speed, accuracy and dependability of the computer make it relevant. The success of implementing the health application depends on a variety of factors, including their cost effectiveness, ease of use and ability to improve on existing processes.

1.1   Objectives of the Study

This research work studies the concept of object oriented and object-relational database so as to be able to apply them in designing a complete administrative information system application for National health insurance scheme.

2.0   The Information Structure of the NHIS

The National Health Insurance Scheme (NHIS) is a body corporate established under Act 35 of 1999 by the Federal Government of Nigeria {NHISGuide} to improve the health of all Nigerians. The establishment of the Scheme was informed by: The general state of the nation's healthcare services, The Excessive dependence and pressure on government provided facilities, The dwindling funding of healthcare in the face of rising cost and the poor Integration of private health facilities in the nation's healthcare delivery [NHIS Guide].

Health insurance is a social system that guarantees the provision of needed health services to persons on the payment of token contribution at regular intervals.

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2.1   Classification of NHIS Programmes

In order to ensure that every Nigerian has access to health care services, the National Health Insurance scheme; the under listed programmes has been developed to cover the different segments of the society ([NHISGuide]. These are: Formal Sector Social Health Insurance Programme, Urban Self-employed Social Health Insurance Programme, Rural Community Social Health Insurance Programme, Children under Five Social Health Insurance Programme, Permanently Disabled Persons Social Health Insurance Programme and Prison Inmates Social Health Insurance Programme.

2.2   Information Flow within the NHIS

Below is a diagrammatic representation of the data flow within the National Health Insurance Scheme (NHIS).
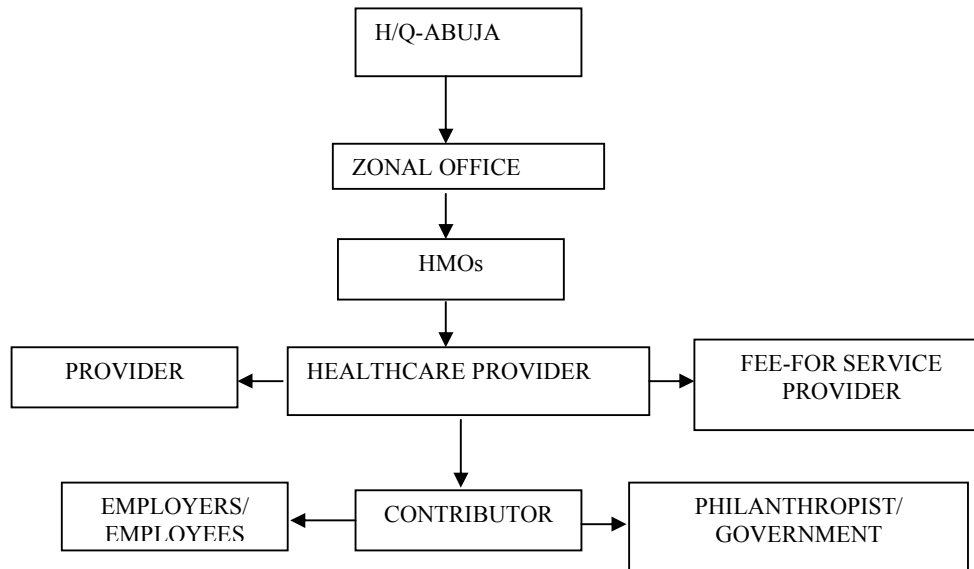

Fig 1: Information flow within the NHIS

The National Health Insurance Scheme has its headquarters located in Abuja, the Federal Capital Territory, from where her administrative activities are carried out. The administration of the NHIS involves stake holders, including: **The Government(** sets standards and guidelines, while protecting rights and enforcing obligations of all stake holders), **Health Maintenance Organizations (HMOs)(** These are private or public institution or body corporate registered by the scheme to utilize its administration to provide health care services through health care providers approved by the scheme**), Health Care Provider(** are licensed Government or Private Health Care Practitioner or facility, registered by the Scheme for the provision of prescribed health benefits to contributors and their dependants. This can either be primary health care providers or fee-for service health care provider. The primary health care provider serves as the first contact with health care system. They include private clinic\hospital, primary healthcare centres, nursing and maternity homes, outpatient department of General, Specialiat and Teaching Hospitals. The fee for service health care providers render services to the contributors on referral from the primary health care provider, they include Specialiat doctors, Pharmacist, Nurses\Midwives, Medical laboratory Scientist, Radiographers, Physiotherapists and Dentist), **Employees(** These are the contributors under the Formal Sectors Social Health Insurance Programme. They contribute 5% of their basic salary regularly), **Employers(** Employers are public or private sectors organizations employing ten or more persons, They are expected to contribute 10% of employee's basic salary), **Other Contributors(** Other contributors to the scheme include: Self-employed persons (businessmen, market women, traders, artisans, farmers, etc). They pay their contributions either by themselves or through cooperatives formed by them, Vulnerable groups (the aged, the disabled, street Children, the retarded and retirees). These have their contributions paid by the Federal, State and Local Governments, Non-Government Organizations (NGO), Local Communities and philanthropist), **Rural Dwellers** and **Board of Trustees (BOTs)**.
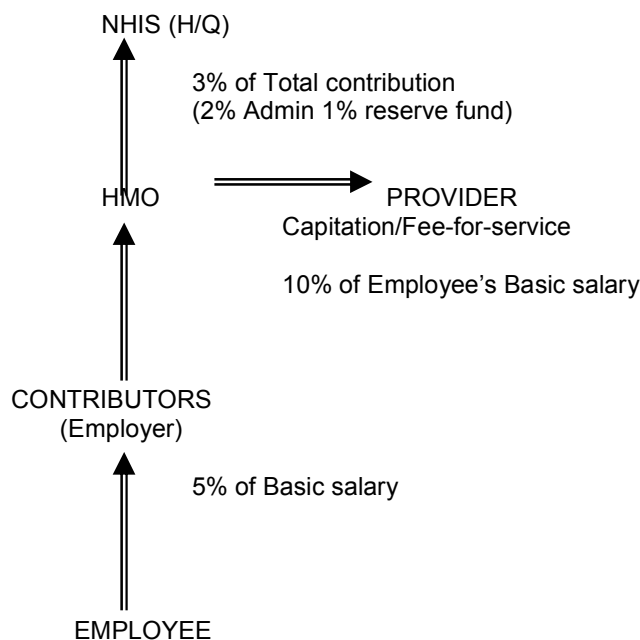
Other Stakeholders: These include:
(i)   International Organizations and Collaborating partners.
(ii)   Non-Governmental Organizations
(iii)   Community Leaders and
(iv)   Media. The International Organizations and

Collaborating Partners have the role of providing technical and financial assistance to ensure successful implementation of the scheme. The major focus in this instance involves the Urban Self-employed, Rural Community, permanently Disabled persons and Children under Five social Health Insurance programmes. The Non-Governmental Organizations are to assist in the area of sensitization and mass mobilization to ensure adequate participation. The communities Leaders do the community mobilization and coordination while the media assist in same using their global networks.

2.3   Providers Payment/Billing System

The diagrammatic representation of the flow of financial transaction within the scheme is shown in below.

NHIS (H/Q)

3% of Total contribution
(2% Admin 1% reserve fund)

HMO ⟹ PROVIDER
Capitation/Fee-for-service

10% of Employee's Basic salary

CONTRIBUTORS
(Employer)

5% of Basic salary

EMPLOYEE

Fig 2:   Flow of Financial Transaction

The arrow shows the order of financial transaction flow. Flat rate contributions are expected on a monthly or instalmental basis from individuals under the Urban self-employed and Rural Community Social Health Insurance programmes.

2.4   Administration of NHIS Programmes

Under the Formal sector Health Insurance Programme, the National Health Insurance Scheme registers eligible employers, who are allowed to choose any Health Maintenance Organization from an NHIS approved list. Employees of these organizations and their dependants are then registered with the scheme and issued identity cards, after which they are required to register with an NHIS –approved primary health care provider of their choice, who they will consult for all their healthcare needs (NHISGuide). Under the scheme a contributor is free to change his primary health care provider after a minimum period of six months should he be dissatisfied with service rendered. The case is different with the Urban self- employed and the Rural community social health insurance programmes. Participant under these programmes are expected to elect a Board of Trustees. Where the group is made up of more than one composite unit or Association, each unit or Association must be represented in the Board. This Board shall have seven elected officers made up of the Chairman, Secretary, Treasurer and four others. A clerk should be appointed to carry out clerical and accounting duties. Executive powers are vested in the Board of Trustees. The Board will be responsible for making collections from participants, paying providers for services rendered and opening a bank account with NHIS-approved banks. Payments are authorized by the Chairman and any one of the three signatories to the account. The Board of Trustees is expected to document all income and expenditure of the User Group. The National Health Insurance Scheme manages the Children under five, permanently disabled persons, prison inmates' social health insurance programmes.

3.0   METHODOLOGY

3.1   System Analysis for NHIS Information System

This includes Consideration for the registrations of providers and health maintenance organizations (HMO), Processing and preparation of Bills, Collection of payments from the various categories in the scheme, Screening, verification and allocation of NHIS number, Documentation of patient's record by NHIS approved providers and others.

3.1.1   Data Gathering

In this research, questionnaire, written documents, interviews and sampling are employed as tools to gather facts during the problem definition stage. After the data gathering phase, some tools are used to analyse the proposed system to determine how it should operate. These tools are: Form Analysis and Object-Oriented analysis. Some forms such as Patient registration form, Provider's registration form, Health maintenance registration form, Bill Generation forms etc

are used in the analysis phase. Also several modeling methodologies were considered, though the main design tool used in this work is the Unified Modeling Language (UML) design tool and notation for object-oriented analysis. At the centre of UML there are nine kinds of modeling diagrams, but only Use Case Technique and activity chart are used in this work.
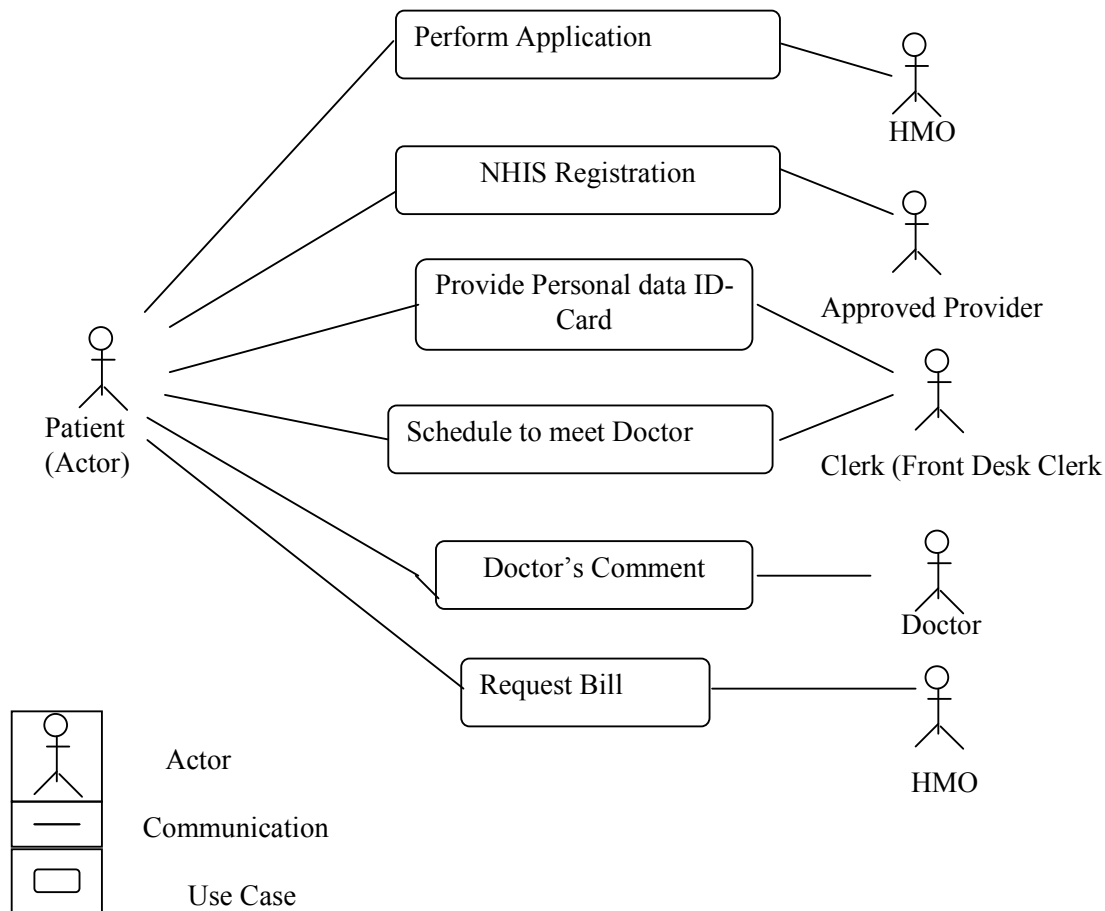
3.2   NHIS Object Modeling in UML

Fig 3: Use case Diagram

Use Case Diagram: (see figure 3) helps to identify the objects that are in the real-world process, trying to provide solution for the operations that occur on those objects.
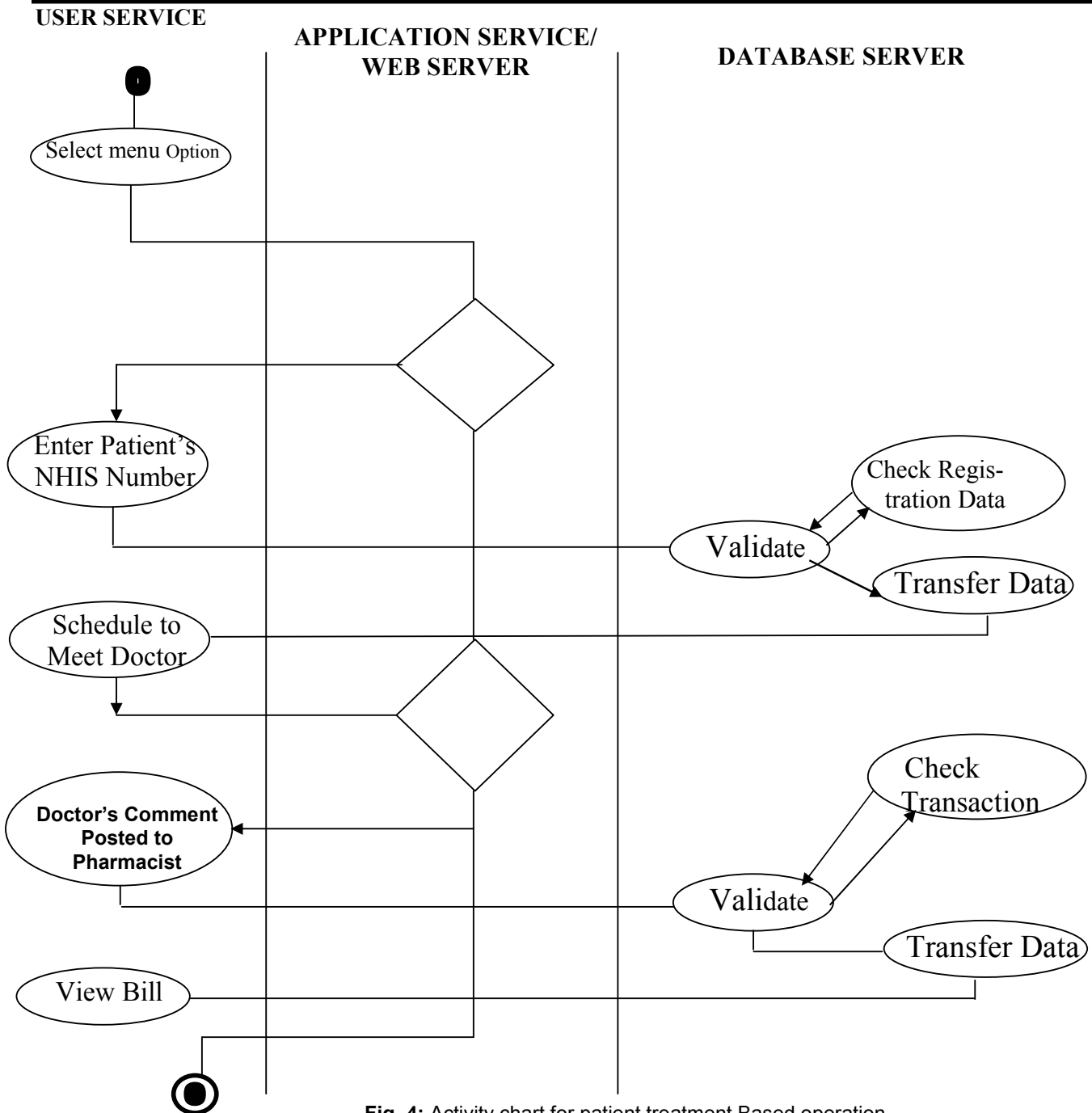
Fig. 4: Activity chart for patient treatment Based operation

The three basic aspect of object oriented database design (encapsulation, inheritance and polymorphism) are employed in the design of the system.

The classes and objects correspond to the entities present in the NHIS System.

3.3 Components of the Model

The model for this study follows the following process

    i. Identify the entities/objects
    ii Identify the attributes of the entities
    iii Identify the data stores (Relational tables)
    iv Determine the process

    v. Develop the application

    -The Entities/Objects used in the study (i.e. super or Base class) are Patients, Providers, HMOs, Employers, Referrals, Testtxn, Transactions, Treatment Txn, DrugTxn. As an example, in this research work Providers is a class. Govtprov is a type of provider. Likewise, PrimaryProv and ProfserviceProv. A GovtProv object will always have a complete Provider Object inside it – with all its data members and methods. This does not mean that all the members defined in the provider class are available to methods that are specific to the GovtProv class.

    -Identification of the attributes of the Entities/Objects: Some of the parameters (instance

variables or attributes) that define the instance of the class Patients are:

PatientNHISNumber, PatientPrimaryID, PatientType, PatientSurname, PatientFirstname, PatientMiddle name, PatientDateofBirth, PatientGender, PatientMaritalStatus, PatientSpouseNHISNumber, PatientWeight, PatientHeight, PatientExpired, PatientAddress1, PatientAddress2, PatientLGA, PatientState, PatientPostCode, PatientZone, PatientEmail, PatientTelephone, PatientPlaceofBirth, PatientNationality, PatientCountryofBirth, PatientReligion, PatientEthnicOrigin, PatientDependants, PatientBloodGroup, PatientGenotype, PatientDistinctMarks, PatientAllergies, PatientPrimaryHMOID, PatientRegistrationDate, PatientNextofkin, PatientNOKLGA, Relationship, PatientNOKAddress1, PatientNOKAddress2, PatientNOKTelephone, PatientEmployerID, PatientContributionsofar, PatientAmountusedsoFar, PatientBalanace, PatientLasActivityDate, PatientLastHMOID, PatientPicture, PatientComments. These variables are the field-contents of the relational table patients.

The attributes used for the PROVIDERS class are:
ProviderID, ProviderType, ProviderName, ProviderSpecialty, ProviderAddress1, ProviderAddress2, ProviderLGA, ProviderState, ProviderPostCode, ProviderGeoPolZone, ProviderTelephone, ProviderFax, ProviderEmail, ProviderWebsite, ProviderRegnDate, ProviderRating, ProviderStatus. These variables are the field-contents of the relational table PROVIDERS.

The attributes used for the HMOS class are:
HMOID,HMOname,HMOAddress1, HMOAddress2, HMOLGA, HMOState, HMOPostCode, HMOGeoPolZone, HMOTelephone, HMOFax, HMOEmail, HMOWebsite, HMORegnDate, HMORating, HMOStatus. These variables are the field-contents of the relational table HMOs.

The attributes used for the EMPLOYERS class are:
EmployerID, EmployerName, EmployerAddress1, EmployerAddress2, EmployerLGA, EmployerState, EmployerPostCode, EmployerZone OrLocation, EmployerContactPerson, EmployerSector, EmployerTelephone, EmployerEmailAddress, EmployerWebsite. These variables are the field-contents of the relational table EMPLOYERS.

The attributes used for the REFERRALS Class are:
ReferralID, ReferredByProviderID, ReferredToProviderID, PatientHMOID, ReferralDate, ReferralReason. These variables are the field-contents of the relational tables REFERRALS.

The attributes used for the TestTxn class are:
TestTxnID, TransactionalID, NHISPatientNumber, HMOID,ProviderID, TestCarriedOut, TestProcedure, TestResult, TestDoctor, TestLabTechnician, TestDate, TestCost, TestComments. These variables are the field contents of the relational table TESTTXN.

The attributes used for the TRANSACTIONS Class are:
TransactionID, TransactionType, TransactionDate, HMOID, ProviderID, PastientNHISNumber, ReferralID. These variables are the field contents of the relational table TRANSACTIONS.

The attributes used for the TreatmentTxn class are:
TreatmentTxnID, TransactionID, PatientNHISNumber, HMOID, ProviderID, TreatmentGiven, TreatmentResult, TreatmentNurseIC, TreatmentDoctor, TreatmentCost, TreatmentDate, TreatmentComment. These variables are the field-contents of the relational table TREATMENTXN.

The attributes used for the DrugsTxn class are:
DrugsTxnID, TransactionID, PatientNHISNumber, HMOID, ProviderID, DrugsGiven, DrugsDosage, DrugAdministered, DrugAdminDate, DrugAdminBy, DrugCost, DrugCsomment.
The derived classes have their specific attributes identifying their peculiar nature and activities within the National Health Insurance Scheme.

• Identification of the Data stores(Tables)
This project makes use of several tables which constitute the data dictionary for this study. The database was designed in Microsoft Access; the database filename is NHIS.mdb. the tables used are the following: Patient, Providers, HMOs, Employers, Referrals, TestTxn, Transactions, TreatmentTxn, PatientType, ProviderSpecialty, provider Type, Rating, Relations, Religion, States, Status, Blood Group, Country, Dependants, Doctors, DrugsTxn, EmploySector, Gender, Genotype, Geopolzone, LGAs, MaritalStatus.

• **Determine the Process**

The Algorithm used in the design is as below

Step 1 - Patient is ill
Step 2 - Patient visits a provider
Step 3 - Identify user NHIS Number?

IF user found
Open patient Registration form
And Register visit, see a doctor,
Sickness is diagnosed
                Else
                        Stop

Step 4 :-Need to go for test
        IF yes?
        Doctor's Comment posted to
        Lab technician /Radiographer/ Referrals etc.
        Lab Result posted to doctor
                ENDIF

Step 5: Drug Prescription posted to pharmacist
Step 6: Drug Bill Posted to Doctor
Step 7: Total Bill posted to Patient HMO
Step 8: HMO pays providers
Step 9: Stop.
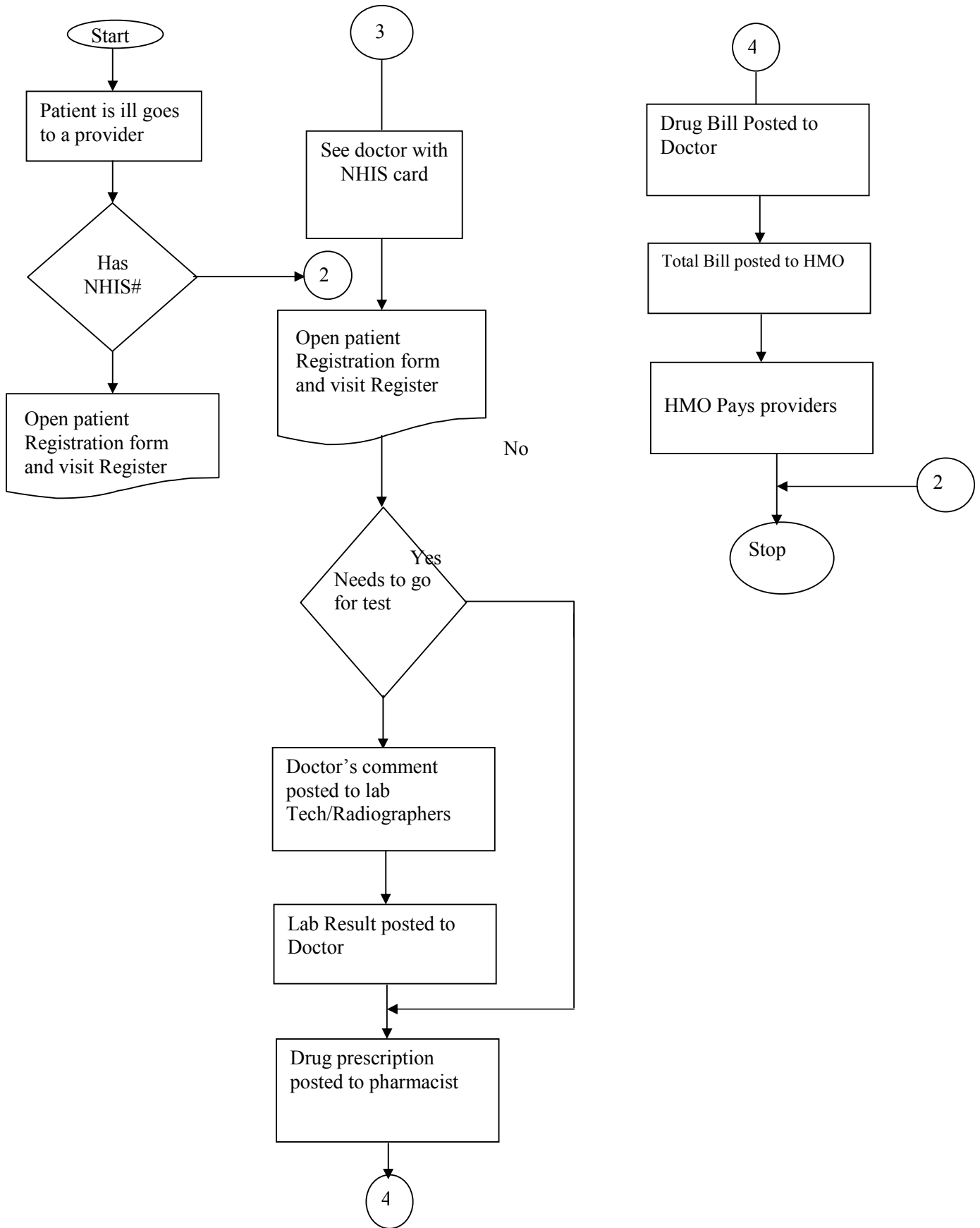
Fig 5: System Flowchart for the Process

• **Develop the Application**

This application is developed using development tools and software on Microsoft windows XP(Professional Edition). Under windows XP Operating system, Macromedia Dream Weaver MX 2004(Web Development Tool) is used along side with cold fusion mark-up language(Web Scripting language), and Microsoft Access 2003 as the database server. Dream

weaver MX is used to create HTML pages and pages based on scripting technologies. CFML is a server-side HTML embedded scripting language.

3.3   Proposed NHIS System Architecture

The proposed architecture will use three-tier architecture with cold fusion as the middle tier; the front-end will be cold fusion mark up language and Microsoft access as the backend.
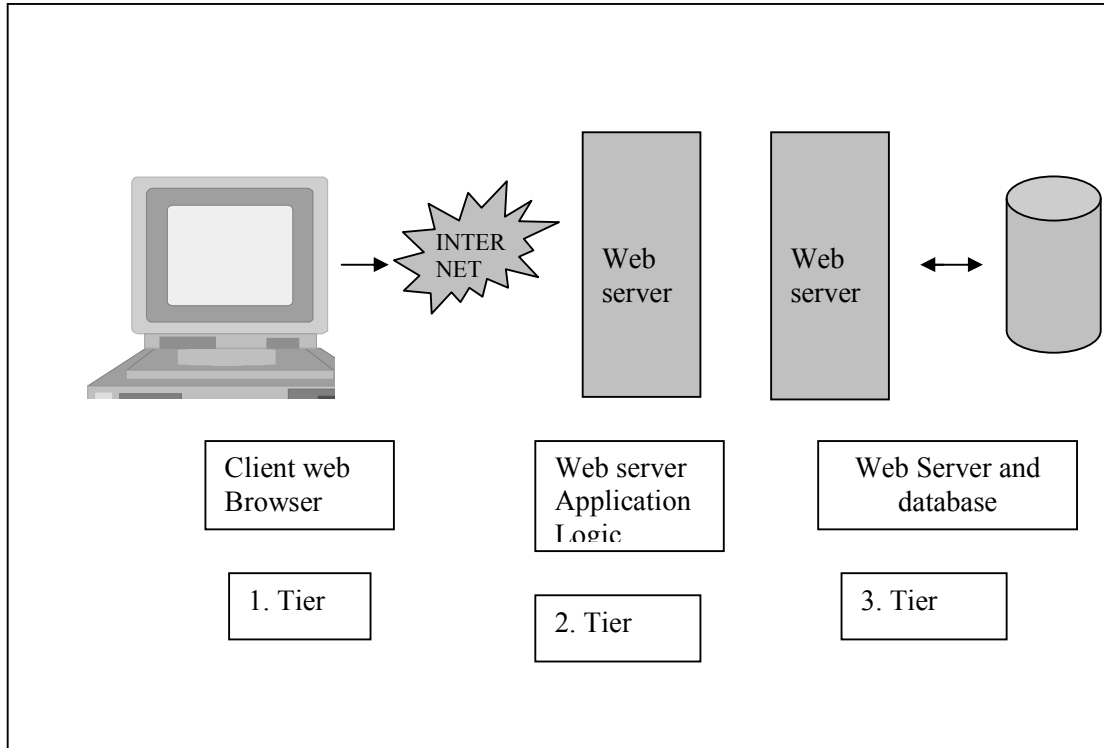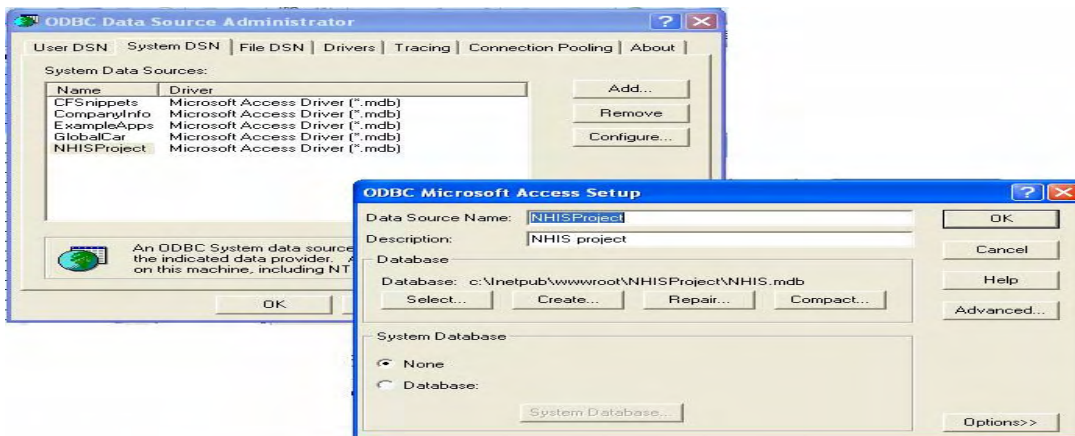

Fig 6: Proposed NHIS System Architecture

4.0   EVALUATION AND IMPLEMENTATION

In other to connect the backend database(NHIS.mdb) created in Microsoft access to the

front end scripting code writing in CFML the dialog boxes below are configured to create the connection.
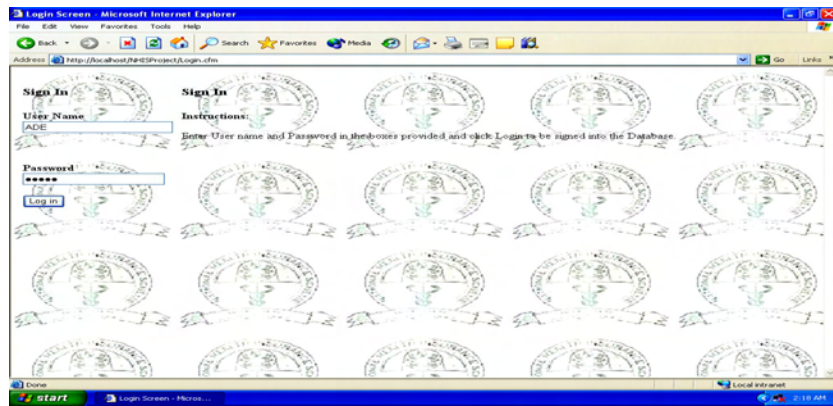

Fig 7: Data Source Connection Dialog box

Program Implementation

To use the application from your desktop launch the internet explorer, in the address box provided; type http://localhost/NHISProject/login.cfm and press the enter key or click the Go button next to the address box. This will take user to the login page. The login page is as depicted below in fig 11:


Fig 8: Login page

This login page allows for user authentication; the user is allowed a maximum of three trials before access is denied. If the password and the user name entered tally with the existing password and user name in the database, the menu page from whence appropriate selection is done is displayed as follows:

Fig 9:   Menu Selection page

If choice selected by the user is front desk clerk, a provider's front desk query page will be displayed as follows:
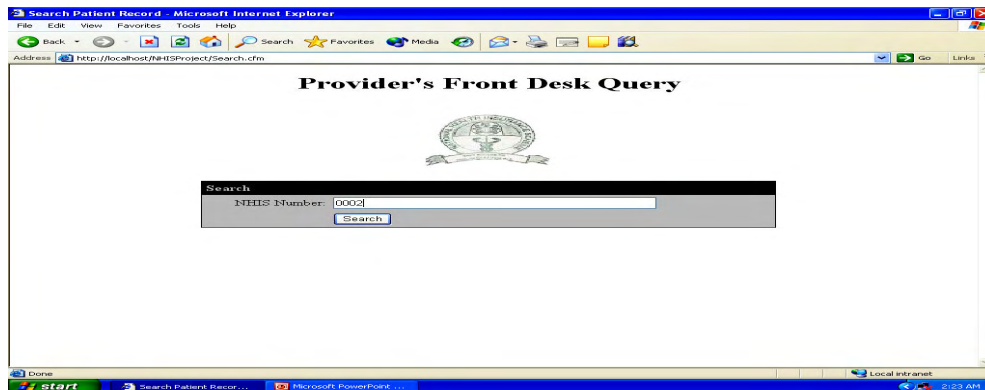
Fig 10: Provider's Front Desk Query Page

This page allows the front desk clerk to query the database for information about the patient using the patient NHIS number. If the patient NHIS number is valid, the provider's front desk patient information page will be displayed as follows:
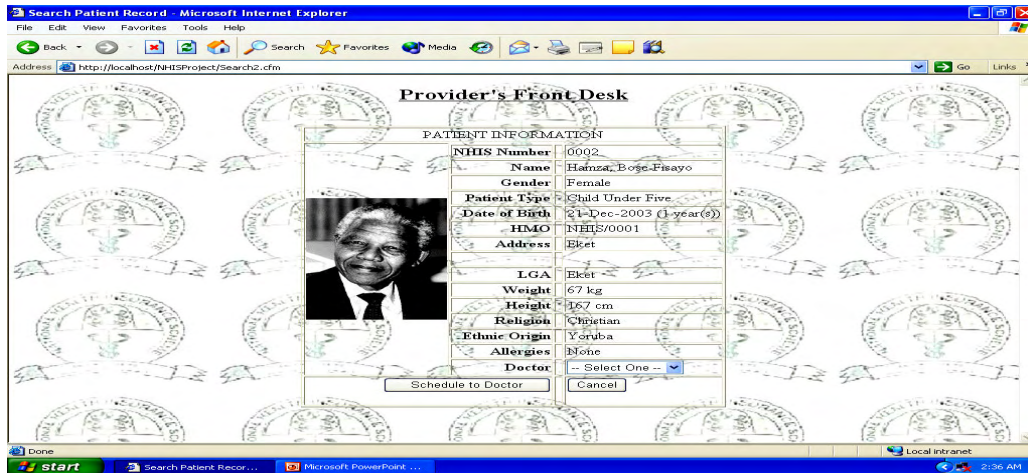

Fig 11: Provider's Front Desk (Patient Information) Page

This page allows the provider's front desk clerk to make a choice of doctor's selection for patient based on patient's preference. He now schedules the patient to meet the doctor. Once the patient has been scheduled to meet the doctor; the patient record will now be added to the doctor's yet to be treated patients' list. On scheduling the patient to meet a doctor, the menu page will appear. When a doctor selects the doctors option from the menu option page. The doctor's selection page depicted below will be displayed.

Fig 12: Doctor's Selection Page

The doctor selects his name from the drop down list box and clicks on the select button to see all the list of patients that have been scheduled to see him for that particular day. This page is called the doctor's yet to be treated patients page, and is as depicted below.
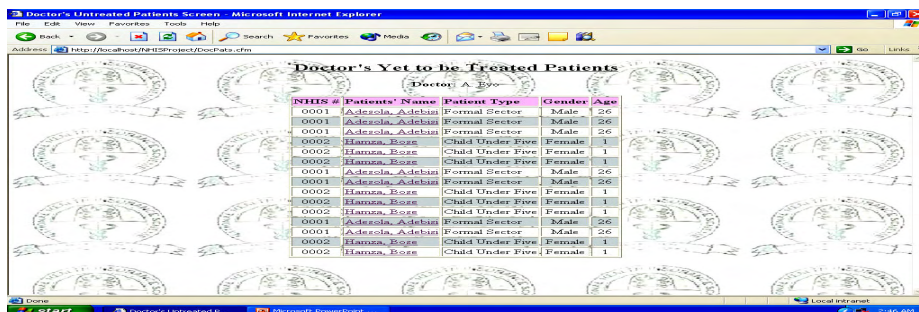

Fig 13: Doctor's Yet To Be Treated Patients Page

The doctor merely needs to click on the patients as it is scheduled on this page for him to see the comprehensive medical details on the patient. The screen that displays this comprehensive detail is called patients details record page. This page allows the doctor to give his comment about the patient's ailment and his subsequent recommendation as to whether patient is to go for laboratory test, sent to a radiographer, referred to a specialist, sent to surgery for operation, sent to pharmacy or need no treatment but to be counseled as the case may be. This page is as depicted below:
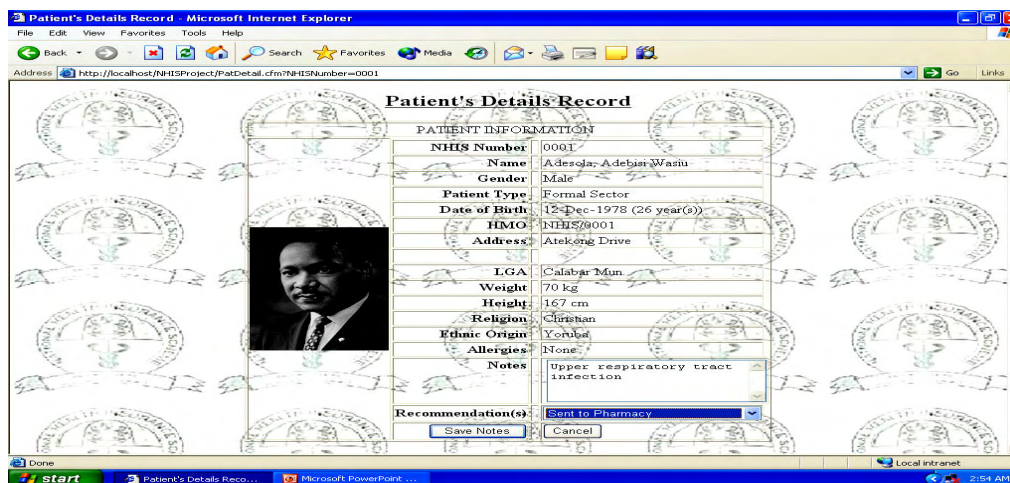

Fig 14: Patient's details record Page

Based on the doctors recommendations and comments sent by those referrals and the bills from them. The doctor will now submit the total treatment bill to the relevant authority for bill computation and compilation for onward delivery to the health maintenance organization.

5.0   CONCLUSION

The Internet has provided a significant technological advancement in the way and manner information are manipulated and managed. Securing and accessing this information anywhere and anytime is one major benefit of web-based applications. This study has been able to present a comprehensive design, development, implementation and analysis of an object-relational database design of an information system for National Health Insurance Scheme (NHIS). It is our belief that if properly implemented as proposed here, it will go a long way in removing the bottlenecks inherent in manual processing and provide a better and broader information security, availability, and advanced tools to manage all types of data. This work is an extension of a pioneering work which handles only the registration of stake holders in the scheme.

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