An Information Databank Framework for the Health Care Industry in Nigeria

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Abstract

The development of web based database systems for service industries has led to a remarkable new dimension of information retrieval and distribution. These developments allow service industries to make information readily available almost at no cost to the general public. This paper discusses the use of web based database systems to accommodate the health care industry data. Presently, the health care information system in Nigeria consist of series of scattered inter-related data from different health sources and service centres, The Internet being a global village was used as a tool to solve this information problem by capturing all these related data into a data repository online where it can be accessed as information. The design uses the three-tier web model architecture as its underlying technology and presents an Information databank capable of storing health care data. This system when deployed will be advantageous in that it saves time and resources for both health administrators and the people; it also helps with health statistics and opens a new market trend for the health industry. However, since this is a prototype design, major improvements such as increased infrastructure, query optimization need be done to accommodate large scale deployment.

Categories and Subject Descriptions: H 3.5 [**Information Storage and Retrieval**] – Online Information Services – Web Based Services.
General Terms: Design, Database System.
Additional Key words and Phrases: Databank, Health, Health Care System, Nigeria

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1. INTRODUCTION

The Health Care Industry in Nigeria unlike developed countries in Europe and North America is a growing one. This is obvious in the unavailability of medical care, functional health care system and the attention

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paid on health services by the public and private sectors. However, in the last decade, major improvements were witnessed in this sector in Nigeria and Africa at large. These improvements are made evident in the restructured modalities of the Nation's Health Care systems vis the changing pace of health services delivery, increased competence of Medical Practitioners, availability of medical resources and many others.

Health care information system has been defined by Shortliffe and Perreault (2001) as a field of study concerned with the broad range of issues in the management and use of biomedical information, including medical computing and the study of the nature of medical information itself. If physiology literally means 'the logic of life', and pathology is 'the logic of disease', then health informatics is the logic of healthcare which is the science that studies the use and processing of data, information, and knowledge applied to medicine, health care and public health (van Bemmel and Musen, 1997).

The health care system forms a major building block of the Health care industry and some of the goals of the health care systems discussed in (WHO, 2000) are good health, responsiveness to the expectations of the population, and fair financial contribution. Duckett (2004) proposed a two dimensional approach to evaluation of health care systems: quality, efficiency and acceptability on one dimension and equity on another. The basics of Heath Care System (HCS), however, remain the same - national coverage for medically necessary health care services provided on the basis of need and quality, rather than the ability to pay.

Two major models were identified according to Wikipedia Encyclopedia, (2008) that have been adopted in the design of health care systems: private and public models. P*rivate enterprise* health care systems are comparatively rare. Where they exist, it is usually for a comparatively well-off subpopulation in a developing country with a poorer standard of health care. For instance, private clinics established primarily to cater for a small, wealthy expatriate population in an otherwise poor country. The other major models are *public insurance systems.* Instances of these could be social security, publicly funded health care, social health insurance health care model and so on; where workers and their families and other country residents are insured by the government.

The basic functional areas of a successful health care industry are e-Health, Funding, Health Care Delivery System, Home & Continuing Care , Hospital Care , Nursing Policy, Palliative & End-of-Life Care , Pharmaceuticals , Primary Health Care , Legislation & Guidelines , Reports & Publication and Health Services just to mention a few. While the strength of these areas is not evident in the present Nigeria health care system, it is worthy to note that the present government is trying to improve the health system of the nation.

This paper's concern is not on the basis or position of the current health care system as it were, it focuses on the issues affecting the availability of health resources, medical expertise, and medical services which includes lack of adequate information, lack of awareness, and proper orientation in the health industry within Nigeria. Thus, the proposed objective is identifying the causes of this problem and proffering a solution through the design of a computer based information system. A *database* is a collection of interrelated data while a *databank* can be considered as a storehouse containing related data, consequently both terms will be used interchangeably within the context of this design.

1.1 Problem Definition

In Nigeria, several factors undermine the effective delivery of the Health Care System. These include *lack of funds, lack of health services, insufficient expertise/professionals* and above all *lack of information* of the few places where particular professional services are being delivered. On the issue of Inadequate Information which is what this paper addresses, Patients and people needing health services are sometimes driven into uncertainty when they are in need of some particular services. It is an accepted fact that the nations health system does not have everything yet but the problem is not really the inadequacy of the health services available, it is more of lack of information of where they can access the little services available.

However, it is not sufficient to say that the nations system does not have this data; it is more of a problem of how majority of the people can have access to this information. The media, advert houses and the newspapers have played their role but as there is limit to their capacity in providing the required health information to the citizen. Thus, how do we decentralize this few health service information and made it available to the general public?

2. A HEALTH CARE SYSTEM INFORMATION DATABANK

The use of the Internet to solve the growing information gap between the limited resources available and the people cannot but be over-emphasized. This System will allow the development of a database system where available health services (both old and new) are made known to the public via a web front. The users of this system being the people, patients, health professionals, and government's e.t.c can make quick enquiries as to the availability of health care systems, health manpower (Doctors, Pharmacists, and Specialists), hospitals, Drug Stores and so on nearest to them. This in turn will break the barrier of lack of information to the people and also help the federal government to make available services to the people while the health Industry catches up with its expected goal of providing correct and good health services in every neighborhood.

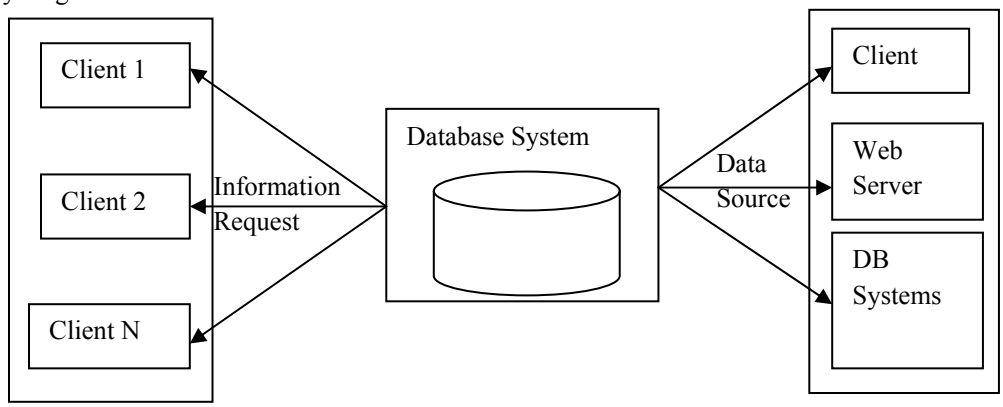

Fig 1: Schematic Representation of the Proposed System.

Figure 1 shows a brief relationship between the Unified Data Repository which contains the details of the health services available, health human resources, locations, health schemes, the health data and its users, primarily the people (the public) who need this information. The question arises of *how the Databank gets its data*? This is provided by the health service providers, health practitioners, the Administrative body in charge of this Information System and a web service technology discussed in later sections of this paper.

3. WEB DATABASE SYSTEMS

The development of dynamic web pages or Web Applications over the Internet has been in operation for over two decades now, This was engineered by the introduction of web scripting languages like cold fusion, PHP, ASP which are used to write application programs that run on the internet and the possibility of developing three-tier applications using databases on the Internet.

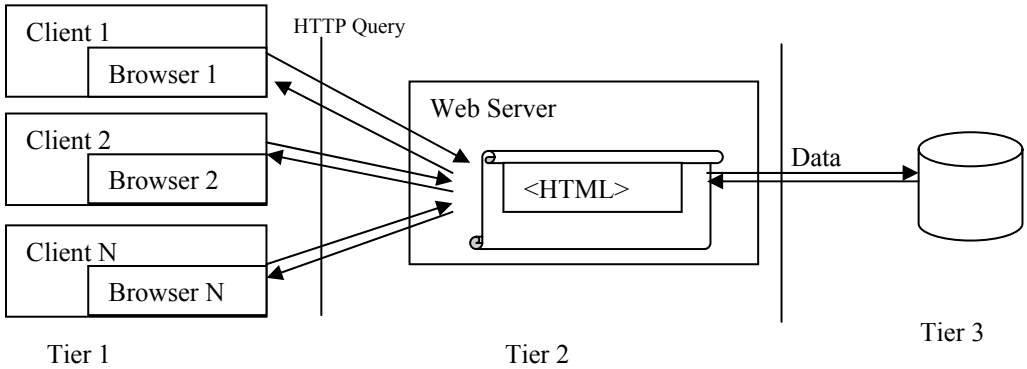

Fig 2: Three (3)-Tier Web Model

Database systems are designed to manage large bodies of information. According to Silberschatz-Korth-Sudarshan (2004), management of data involves both defining structures for storage of information and providing mechanisms for the manipulation of information. In addition, the database system must ensure the safety of the information stored, despite system crashes or attempts at unauthorized access. If data are to be shared among several users, the system must avoid possible anomalous results.
Tarricone and Esposito (2004) described the 3-tier architecture above as having the following;

- The *front-end* tier, the client from which the end user expresses requests by using a browser;
- The *middle* tier, the Web server equipped with software capable of building HTML pages on the fly, starting from data originated by users as well as data fetched from the backend tier;
- The *backend* tier, a backend database where data are stored.

The development of HCS databank will use the Web Model discussed above. While, the front-end tier is concerned by the users and can be used as long as a user is connected to the internet, Attention will be on the Tier2 (Web Server, Web Pages, Application Languages) and the backend tier where the database model and structure of the application will be designed. For the purpose of this application, the Server-side technology used is PHP (PHP Hypertext Preprocessor). It is used in conjunction with HTML to render the web pages on the web. The database system used in MySQL, this is used because of its availability, cost and operational speed.

4. ANALYSIS OF THE PRESENT SYSTEM

The present health care system in Nigeria consists of both public (government) and private institutions. The Ministry of Health is in charge of the public health services provided by the government. Recently health care managers were introduced in Nigeria health schemes. These include National Health Insurance Scheme (NHIS), HYGEA and many others. In the private Sector, Health Institution, Clinics, Blood banks, Pharmaceuticals companies, Drug Stores, Laboratory, Specialist and Doctors all contribute to the success of health services within the country. There exist professional bodies such as Nigeria Medical Association (NMA) for Doctors and Specialist, National Association of Resident Doctors of Nigeria (NARD) (www.nigerianma.org), Nigeria Pharmaceutical Association (NPA) for pharmacists all registered with the aim of fostering common cause as it may affect the health care industry in Nigeria. There is no medium or facility on ground for the acquisition and repositioning of these inter-related data.

4.1 Proposed System Design and Architecture

This system involves the design of a databank that unifies the scattered data of health inter-related services, resources, expertise, funding and so on. In particular, it is designed to house data related to Hospitals, Pharmaceuticals, Laboratories, Blood banks, Special Clinics, Doctors, Health schemes and the services rendered/offered by this categories. The system is designed as a web based system and is proposed to be administered by the Ministry of Health because of her major role in the Nations Health Care System.

The system design uses both the human-centric and application-centric web approach as described in (Codd, 1970). This allows for data to be inputted into the system by the administrative body and also for the application to source for data itself using the XML- service, This is to increase data authentication and integrity, this technology will be employed to retrieve correct and up-to-date data from National Associations e.g. Nigeria Association of Doctors for accredited Doctors and their areas of specialty.

The system architecture below shows the blueprint design of the Information Databank and the flow of data storage and retrieval within concerned entities. In the architecture below, sub section A & B are human centric in that they require input by humans to the web server while sub-section C is application-centric, this involves the web server communicating with another web server for information, both sending and receiving data and information via XML web service.

Section A of the architecture involves two kinds of users. The first sets of users of the system are those who place information request to the system. Their request is sent via the HTTP query to the web server, which in turn fetches the right information and displays the needed information back to their screen. The second sets of users are health care professionals, health service centers e.t.c who register their services and contact within the system. Section B involves the Administrative users, while they can also be seen as query users. Their functions within the system include authenticating registered members and inputting of data into the database via the web server. Their request is also sent via the HTTP query to the web server which in turn performs the query operation and delivers the information requested. Section C involves the

Information System web server communicating with other database system via an XML-web service. The Web server sends XML request as described in Cerami (2002) to the outside web server (this outside web servers being web servers of Health Services body like NMA, NARD, NPA where authentic information about health professionals can be gotten) and receives an XML-response with data which is then used to update its own database.

4.2 Database Relational Design

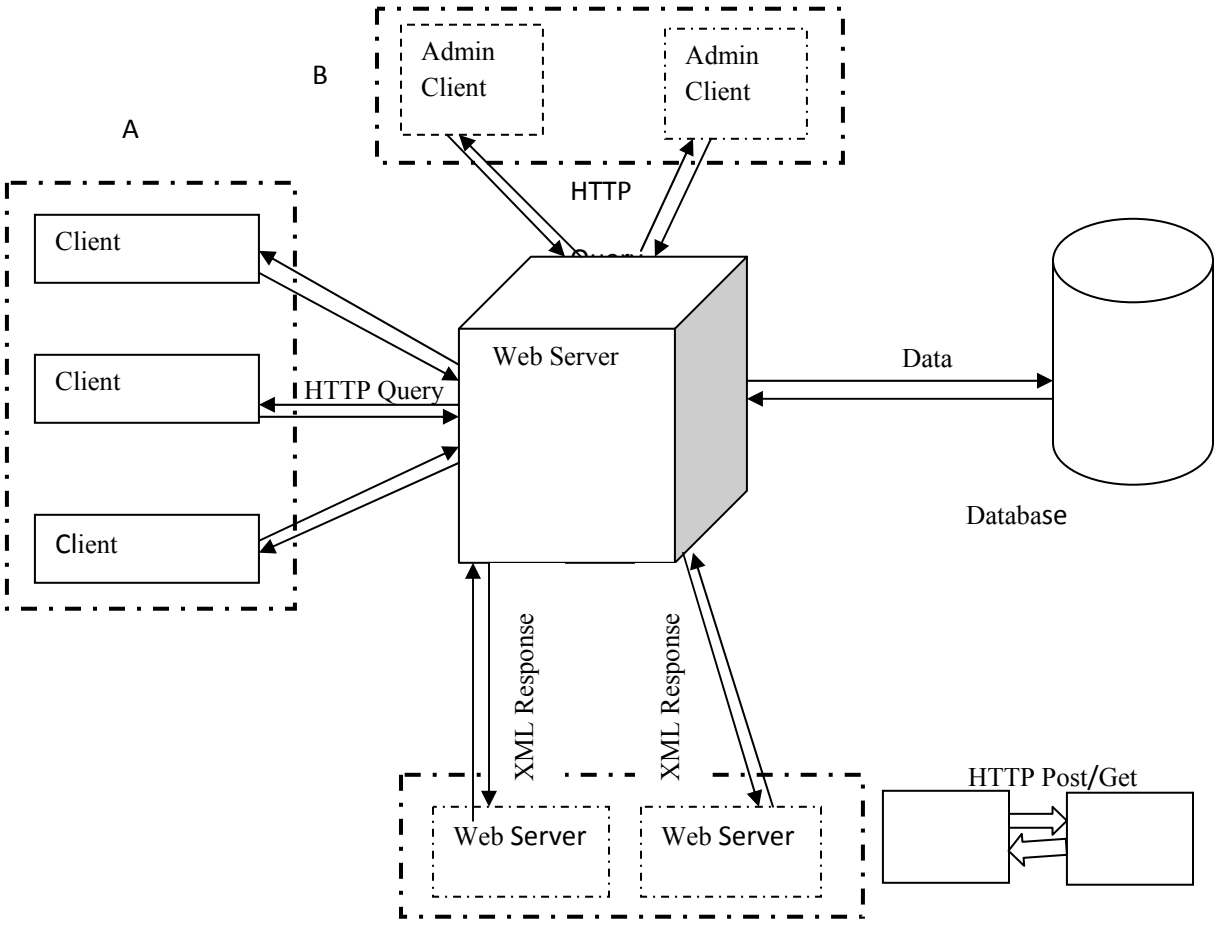

Fig 3: Information Databank System Architecture

Section A of the architecture involves two kinds of users. The first sets of users of the system are those who place information request to the system. Their request is sent via the HTTP query to the web server, which in turn fetches the right information and displays the needed information back to their screen. The second sets of users are health care professionals, health service centers e.t.c who register their services and contact within the system. Section B involves the Administrative users, while they can also be seen as query users. Their functions within the system include authenticating registered members and inputting of data into the database via the web server. Their request is also sent via the HTTP query to the web server which in turn performs the query operation and delivers the information requested. Section C involves the Information System web server communicating with other database system via an XML-web service. The Web server sends XML request as described in Cerami (2002) to the outside web server (this outside web servers being web servers of Health Services body like NMA, NARD, NPA where authentic information about health professionals can be gotten) and receives an XML-response with data which is then used to update its own database.

4.2 Database Relational Design

A relational database consists of a collection of tables, each of which has a unique name. Each table contains columns known as attributes and rows known as tuples which represent relationships among a set of values. According to (Codd, 1970), a Relational Database Model can be represented as:
$R_0 = \{A_1, A_2, A_3, \ldots, A_{n-1}, A_n\}$
Where R represents a relations and A_1, A_2 represents the attributes contained in the relation R. Thus, using the above representation, the database design of the HCS Database with the relations is shown below.
Hospital {*hos_id, hos_name, hos_contact, hos_desg, hos_add, hos_country, hos_state, hos_zip, hos_url, hos_tel, hos_email*}
Pharmacy {*pha_id, pha_name, pha_contact, pha_desg, pha_add, pha_country, pha_state, pha_zip, pha_url, pha_tel, pha_email*}
Doctor {*doc_id, doc_fname, doc_lname, doc_ini, doc_degree, doc_practise, doc_practise_add, doc_city, doc_state, doc_zip, doc_practise_tel, doc_email, doc_url, doc_acc_patient, doc_pri_spe, doc_sec_spe, doc_ter_spe*}
Laboratory {*lab_id, lab_name, lab_contact, lab_desg, lab_add, lab_country, lab_state, lab_zip, lab_url, lab_tel, lab_email*}
BloodBank {*bb_id, bb_name, bb_contact, bb_desg, bb_add, bb_country, bb_state, bb_zip, bb_url, bb_tel, bb_email*}
Special-Clinic {*clinic_id, clinic_name, clinic_contact, clinic_cont_desg, clinic_add, clinic_country, clinic_state, clinic_zip, clinic_url, clinic_tel, clinic_email*}
Medical_Service {medical_id, hos_id, med_echo_lab, med_eeg_lab, med_endoscopy, med_occ_health, med_xray. Med_radio, med_bb, med_unit, med_oxy, med_amb }
Bb_blood *{ bb_blooddetail_id, bb_id, bb_blood_type, bb_avail* }
Capacity *{ capacity_id, hospital_id, cap_bed_type, cap_no_of_bed, cap_staff_str, cap_staff_str_sup*}
Drug_portfolio { *drug_id, pharmacy_id, drug_name, drug_desc, drug_ind*}
Healthcare { *health_care_id, hospital_id, hc_hygea, hc_nhis, hc_others*}
Lab_test { *test_id, lab_id, test_name, test_desc*}
Specialist { *specialist_id, hospital_id, spe_specialist, spe_paed, spe_gyna, spe_dent, spe_derm, spe_surg, spe_other* }
Surgical { *surgical_id, hospital_id, surgical_proc*}
The database table relationship(s) is shown in appendix A.

4.3 Process Design of the System

The process design in Fig 4 below shows a quick view of the application usage from the users' point of view. The Index page which doubles as search query page is the application start phase. The Process flow shows two basic modules of the system, Module A for class A users who use the system basically to request information about health service and practitioners while Module B which is for Class B users (This class of users are the medical practitioners, health service providers who register to make their presence known within the system) is divided into two, New Users and Existing Users, New Users go through the registration procedures while Old users simply login into their member area to edit/update their information. The user information update is required from time to time to maintain an accurate data within the database system.

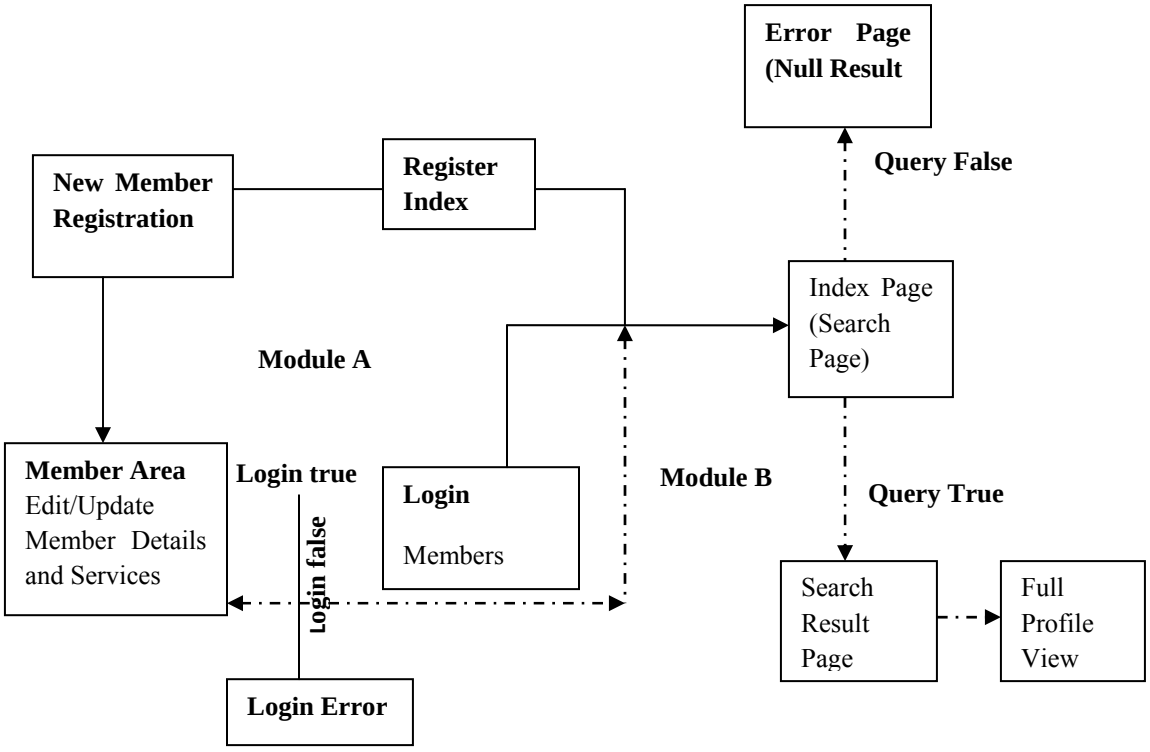

Fig 4: Diagram showing the process flow

As shown in the process flow diagram in figure 4, when a query for information is sent to the database system, the query is processed and subsequently returns a result page if query execution is true or a search error page if query execution is false. Existing Members gain access to their member area using their username and password, once logged in; they can edit and update their information within the database system.

This design was tested on a Pentium III, 900 GHz, 400MB Ram Computer machine with Microsoft Windows XP Professional as its Operating system and the simulation was demonstrated on a stand-alone system.

5. DEPLOYMENT STRATEGY AND APPLICATION USAGE

Just like any web application, this web system will be deployed over the Internet and can be hosted by any Internet web hosting service provider e.g yahoo, hostmonster, resellerguru e.t.c. Such Internet providers must have the capability of hosting PHP/MySQL Applications. Also, the database space must be taken into consideration as the system needs a relatively large database space due to the amount of data expected to be used and analyzed by this system. Once the system as been uploaded, it becomes readily available for use by the general public via the domain name registered for it..

The usage of the system is relatively easy; the index page shown below is the search page of the web system. It shows the search categories that can be used for query search, the register and login links for new and old users respectively and the search system itself.

Fig 5: Search Category Link

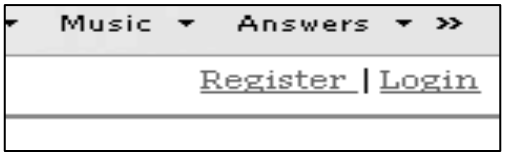

Fig 6: Member Links

Fig 7: Search Page (Index Page)

Once a search category is highlighted and a search request is executed, the query analyzer analyzes the query and returns a result page if query was successfully executed with data like figure 8 below.

Fig 8: Search Result Page

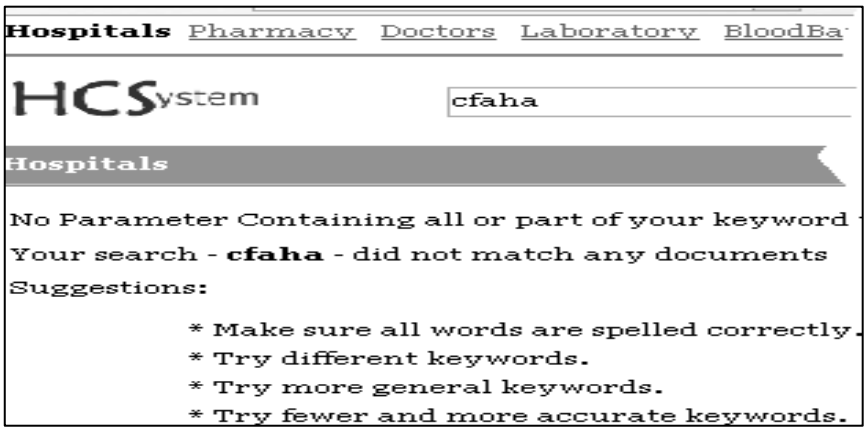

Fig 9: Search Error Result Page

The registration page is shown below; any new member registers under the appropriate category as it fits his/her contribution to the health industry. Once a successful registration has been done, a member area is shown to the user to modify and update details of services; this update of course is required from time to time to achieve an overall up-to-date system.

Fig 10: Registration links

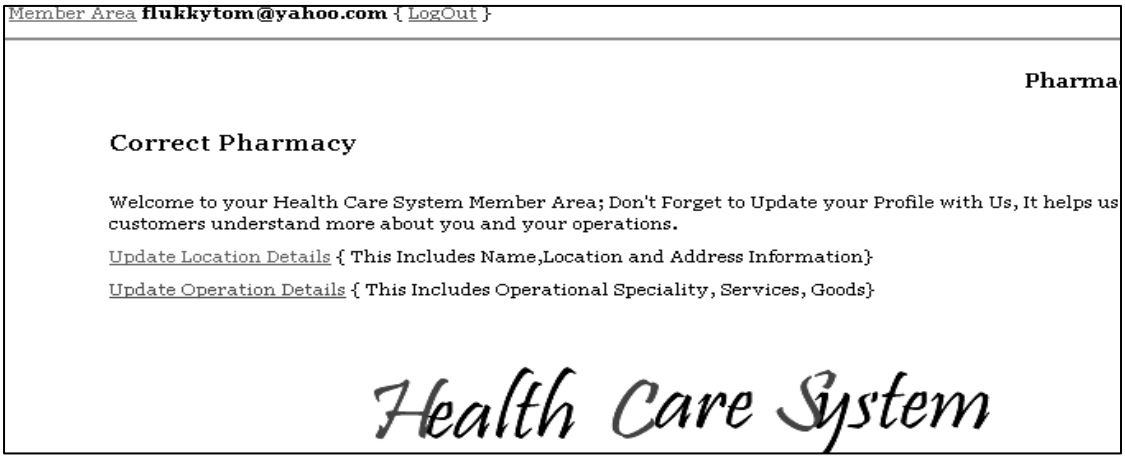

Fig 11: Member Area

5.1 Security and Data Authentication

The security of this web system is crucial because of its sector importance (health), while the security of the system online can be guaranteed relatively to a large extent with the use of a reliable dedicated server online to restrict access and database replication in case of database failovers. The issue of data security and authentication is a major one because this is the core of the information being passed to the public and

the higher the validity of the data, the more useful and reliable it becomes to the people without the goal of the project being jeopardized.
In order to ensure data authenticity, registered users data are not allowed to be processed along search queries unless the data has been validated and verified by the Administrative Body from the proposed registration body of both health practitioners like doctors, pharmacist and health service providers like laboratories, blood banks. The web service structure of the application ensures that data replication is not allowed and also validates data by retrieving data from only specified and authorized data sources.

6. CONCLUSION

This paper presents a technology of improving the health care industry information system with the development of an information databank. Prototype databases was proposed and developed to house health system related data such as health practitioners, health service providers, health schemes e.t.c.; and make it available to the general public via an online system (the internet). If the system is well deployed and managed properly, it will present the capacity of the health industry to the people in a more clearer and readable format.
The advantages of this application when implemented are enormous. These include the presentation of a system that can help the health industry save resources, help the people (public) save time and resources with the availability of timely information of what, where and how about health care services around them. It also presents the government and the health Industry administration a easier medium of gathering heath statistics both at the practitioner level and the service level. This system as it were also presents to the health industry market an avenue to render its services on a much larger scale and thus improving health businesses while bridging the gap between patients and health professionals.

6.1 Limitations of the System

The system has been developed to be workable within the context of our present environment, however, there may exist some limitations in implementing some aspects of the system. The application-centric side of the project to retrieve data by itself will suffer setbacks until there exist a web server and web service infrastructure for its intended data sources online. Another setback may come with the issue of funding the project, As the project will turn out to be a national project, it will require huge investments to keep the system alive and working.

6.2 Future Research

This project despite its relevance and present technology can be improved upon. Further development to improve the design include the need to house more health service data, the need to incorporate the usage of query optimization techniques to fast track query results, expanding of the project to form a specialize database for health services within the country. Another issue is the need to replicate and better optimize MySQL servers which houses the database since it will continue to grow in size so as to improve performance.

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9. Appendix

10. Appendix a: examples of table showing relationship between attribute keys.