DEVELOPMENT OF A DIGITAL INFORMATION SYSTEM FOR HEALTH CARE DELIVERY IN OYO EAST LOCAL GOVERNMENT AREA, OYO STATE

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Abstract

The focus of this paper is on the creation of a digital information system for primary healthcare delivery in Oyo East Local Government Area, Oyo State. The existing manual system of primary health care delivery was examined in eleven primary health centres in ten (10) wards of the study area. Data were acquired through the use of questionnaire, formal and informal interview to gather necessary information regarding the existing system. Participant observation was also adopted in order to understand the working condition and processes involved in the existing system of rendering services in health care delivery at the various primary health centres. There was problem of poor documentation and voluminous files because most of the information processing are done manually. Consequently, a computer based information system called PHCINFO 1.1 was developed. Traditional System life Cycle was used as the system development technology and the database was normalized up to the Boyce/Codd normal form. PHCINFO 1.1 was developed based on the principle of modularization and the program was divided into modules which were in turn divided into sub-modules for ease of development and documentation. The spatial input was made possible through ArcGIS technology while the database was developed using Ms-Access. Visual Basic program was used for the development of the end user interface.The study recommended that Government should always carry out periodic system analysis in order to accommodate new technological challenges that can help the primary health centers function optimally.

Keywords: Healthcare, Primary health center, GIS, Geodatabase

Introduction

Concern about the state of the Nigerian health care system has reached a slow boil. Health care consistently ranks among the top issues that the Nigerian public wants policymakers to address, and it is increasingly intertwined with growing worries about economic insecurity. It is unfortunate that the Nigerian healthcare system has not adequately been meeting the healthcare needs of over 100 million citizens living in poverty. Yet most of the discussion is focused elsewhere (Nwachukwu, 2021)

Improving the quality of services delivered is paramount to enhancing health system performance and motivation for healthcare workers (Adeloye, et,al. 2017). In order to improve the health status of the people, health practitioners need to determine areas with poor accessibility to certain health facilities and then prepare a proposal for improving such situation. This is a large task that needs huge set of a data including health facilities location, catchment areas, and population statistics. Such systems should reduce errors of overuse, underuse, and misuse, and improve the overall coordination of care.

Government has the opportunity to transform health care and improve patient safety by better leveraging information technology to improve the efficiency, accuracy, and effectiveness of our healthcare system. If deployed incorrectly, without well-conceived process improvements, IT systems can do just the reverse, leading to critical delays or mistakes.

Arthur (2020) refers to information technology as all devices that have the capacity to process data and or information, both systemically and sporadically, whether applied to the product or applied in the process. A major category of Information systems is the Geographic Information Systems**.** Its spatial analytical capabilities can help analyze and display data by using digitized maps and imageries. It is an information system which allows the capture, updating and displaying of a number of previously unconnected datasets, bring them into a common reference system for spatial analysis from which relationships can be identified and decision can be made (Sowton 1991).

The power of a GIS comes from the ability to relate different information in a spatial context and to reach a conclusion about this relationship. Most of the information we have about our world contains a location reference, placing that information at some point on the globe. A GIS, therefore, can reveal important new information that leads to better decision making. Many computer databases that can be directly entered into a GIS are being produced by Federal, State, and local governments, private companies, academia, and non-profit organizations. Different kinds of data in map form can be entered into a GIS. A GIS can also convert existing digital information, which may not yet be in map form, into forms it can recognize and use.

GIS has several growing application areas and the Primary Health Sector is not left behind. Baker et al., (2002) examined physical access to primary health care in Andean Boliva in an attempt to use the technology of GIS to assess physical access to primary health care in a remote and impoverished region of area. Likewise, Vitale (2007) was able to deploy the technology of GIS to evaluate access barriers to primary health care services in Hispanic residents in toombs county, Georgia, USA. He was also able to reveal that influx of people to a new region could lay heavy burden on the available primary healthcare centers available in the area which can impair accessibility to the primary healthcare centers.

Martinez et al., (2005) in an in-depth study of analysis of information and communication needs in rural primary healthcare found that primary healthcare centers in rural developing countries are inefficient and are not information technology based though he did not use the technology of GIS for his study. Also, the International Journal of Health Geographics (2008) in a case study of infectious disease mapping across new Brunswick, Canada and maine, U.S.A. developed a web map service-disease surveillance system through the technology of GIS that enables cross-border visualization, analysis, and sharing of infectious disease information through interactive maps and/or animation in collaboration with multiple partners via a distributed network.

Similarly, Salehi (2017), identified the high priority areas which require more maternal health services in Kerman, Iran. He was able to reveal that Women's access to hospitals plays an important role in identifying high priority areas which need maternal care and services. Most of the studies that have deployed the use of GIS for applications at the local health care delivery level had been found in foreign economies. These include: Dulin, 2010; Bazemore, et.al. 2010; Buse, et.al,. (2022);Asabere, et.al (2021). In Nigeria, where GIS technology is just evolving, litte has been done with the use of GIS in rural primary healthcare delivery hence this paper is directed towards the creation of a digital information system for primary healthcare centers within Oyo East L.G.A. of Oyo State, Nigeria. The study area is Oyo East Local Govt. Area, Oyo, Oyo State. It lies approximately between latitude $07^0 51' 58''$N to latitude 07º 50′ 47″ and longitude 03º 56′ 47″E to longitude 03º 57′ 07″E respectively. It is a geo-political area that is semi-urbanized and predominantly Yoruba

2.0 Methodology

The materials and the step by step procedure adopted in carrying out this workarepresented in this section.

Database Design: Database design constitutes one of the core tasks in developing any GIS application. It involves the process by which the real world entities and their interrelationships are analyzed and modelled in order to derive the maximum benefits while using the minimum quantity of data (Kufoniyi, 1998). The design phase consists of three phases namely: Conceptual, Logical and Physical

Conceptual Design: For this paper, the vector approach was adopted. This study is limited to primary health centers in the study area, which are also part of the basic providers of specialized health care services. There are eleven (11) primary health centers and ten (10) wards in Oyo East Local Government. The selected primary centers were: Oyo East Local Government Staff Clinic, FSP Clinic Oke-Apo, Jabata Maternity Centre, Oba Adeyemi Health centre, Araromi Health Post, Ajagba Maternity Centre, Ona – Aka Health Centre, Idode Health Post, GudugbuOrile Health Centre, Ayedoyin Health Centre,Alaodi/Modeke Maternity Health Centre. Functional activities considered in the primary health centers are Vaccination, Manpower, Service provision and HealthCenter facilities. The following are the wards in Oyo East L.G.A according to the 2003 population censusAgboye/Molete ward, Ajagbaward,Alaodi/Modeke ward, Apaara ward, Apinni ward, Balogun ward, Jabata ward, Oke-Apo ward, Oluajo ward, Owode/Araromi. Other entities considered in this paper include Health facilities, Vaccination, Services provided and manpower. The Entity-Relationship diagram is depicted in figure 1

Logical Design: For this aspect of design, the implementation data attribute data model was the relational database model, Tables were translated into tables, attributes becomes field of the tables. The tables considered were Tables 1.2.3.4.5 and 6.

Data Sources

Primary Data Source

Data used were collected from two main sources, (i) Primary Source (ii) Secondary Source. This study was conducted through the collection of data and necessary information from both primary and secondary sources. Primary data was gathered through the use of questionnaire, formal and informal interview, in order to understand the existing system used for healthcare delivery. Each of the primary health centres was visited and questionnaires given to the respective heads to fill. Participant observation was used for some of the primary health centers whose heads were not very receptive to understand the processes and the working conditions being used in healthcare delivery. The positional values (coordinates) of the selected primary centers were also acquired through the Global Positioning System (GPS). Each of the primary health centers was visited and their positional values were acquired, documented for further processing. The hand held GPS used was Garmin (GPS 72).

Secondary Data Source

The secondary data set include textbooks, publications such as quarterly magazines, Nigerian daily newspapers, as well as other sources of information. Others include the collection of base map from the survey division of the Local Government. Oyo ikonos imagery was also obtained from the National Airspace for Scientific Research and Development Agency (NARSDA). It was from the Oyo Ikonos imagery that the imagery of Oyo East Local Government was delineated and super imposed over the base map of the L.G.A.

Physical Design: This stage is referred to as the implementation stage. It involves the representation of the data structure in a format of the implementation software.This is depicted in Table 7, Table 8, Table 9 and Table 10, Tables 11 and Table 12 respectively

Tables and Figures

The Entity-Relationship diagram is depicted in Figure 1 below while both the Conceptual Schema and Physical schema are both depicted in tables 1 to table 12

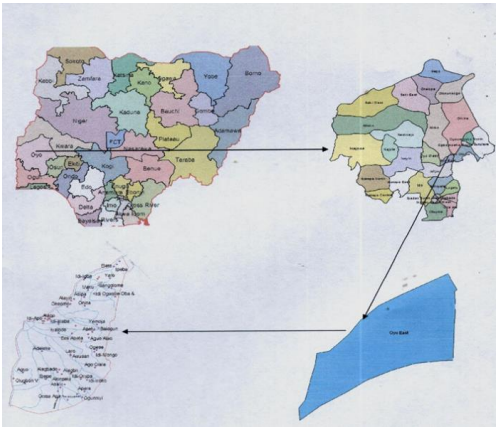


Fig. 1 :Entity Relationship diagram of the Study Area

Logical Schemas

Table 1: Health facilities table and attributes

Field name	Description
phccodd	primary health centre code
light_sources	sources of light
water_sources	sources of water
nos_of_buildings	number of buildings
nos_of_bedspaces	number of bedspaces
hwardcode	wardcode of the primary health centres

Table 2: Ward table and attributes

Field name	description
wardname	name of ward
wardcode	ward code
phccod	primary health centre code
phc_name	name of phc

Table 3: Vaccination table and attributes

Field name	Description
vaccination_type	type of vaccination
sponsor_vaccination	sponsor of vaccination
financial_sponsorship	financial sponsorship
Phcno	primary health centre code
Vwardcode	ward code

Table 4: Service Provision table and attributes

field name	description
Swardcode	ward code
phc_cod	primary health centre code
ph_name	primary health centre name
services_provided	services provided

Table 5: Manpower table and attributes

Field name	Description
Phname	primary health centre name
phc_code	primary health centre code
nos_of_doctors	number of doctors
nos_of_nurses	number of nurses
nos_of_auxillary_nurses	number of auxillary nurses
nos_of_medical_tech	number of medical technicians
nos_of_midwife	number of midwives
nos_of_senior_comm_worker	number of senior community worker
phc_manpower	manpower in the primary health centre

Table 6: Primary Healthcenter table and attributes

Field name	Description
Phcname	primary health centre name
Phchead	head of primary health centre name
date_established	date established
Pwardcode	ward code
nos_communities_served	number of communities served
Phcode	primary health centre code
birth_rate_month	birth rate per month
death_rate_month	death rate per month
Shifting	Shifting
Address	Address
staff_strength	staff strength

Physical Schemas

Table 7 File Structure for Health facilities table

Field name	Data type	Description
phccodd	text	primary health centre code
light_sources	text	sources of light
water_sources	text	sources of water
nos_of_buildings	number	number of buildings
nos_of_bedspaces	number	number of bedspaces
hwardcode	number	wardcode of the primary health centres

Table 8 File Structure for Ward table

Field name	Data type	description
wardname	Text	name of ward
wardcode	number	ward code
phccod	Text	primary health centre code
phc_name	Text	name of phc

Table 9 File Structure for Vaccination table

Field name	Data type	Description
vaccination_type	Text	type of vaccination
sponsor_vaccination	Text	sponsor of vaccination
financial_sponsorship	Text	financial sponsorship
Phcno	Text	primary health centre code
Vwardcode	Number	ward code

Table 10 File Structure for Service Provision table

field name	data type	description
Swardcode	number	ward code
phc_cod	text	primary health centre code
ph_name	text	primary health centre name
services_provided	text	services provided

Table 11 File Structure for Manpower table

Field name	Data type	Description
Phname	text	primary health centre name
phc_code	text	primary health centre code
nos_of_doctors	number	number of doctors
nos_of_nurses	number	number of nurses
nos_of_auxillary_nurses	number	number of auxillary nurses
nos_of_medical_tech	number	number of medical technicians
nos_of_midwife	number	number of midwives
nos_of_senior_comm_worker	number	number of senior community worker
phc_manpower	text	manpower in the primary health centre

Table 12 File Structure for Primary Health center table

Field name	Data type	Description
Phcname	text	primary health centre name
Phchead	text	head of primary health centre name
date_established	text	date established
Pwardcode	number	ward code
nos_communities_served	text	number of communities served
Phcode	text	primary health centre code
birth_rate_month	number	birth rate per month
death_rate_month	number	death rate per month
Shifting	text	Shifting
Address	text	Address
staff_strength	number	staff strength

Database Creation

Following the design phase, the database was created and populated in ARCGIS 10.5 environment. Line, Point and polygon layers were created respectively for the phenomena of interest. These form individual relations which were then populated with their attribute values.Visual Basics Programming language was chosen as the development tool.

Results

PHCINFO 1.1 was developed based on the principle of modularization and the program was divided into modules which were in turn divided into sub-modules for ease of development and documentation. The modules were desk checked to have limited error during coding. The modules developed include:



Figure 2: The Welcome Interface of PHCINFO 1



Figure 3: Menu Interface of PHCINFO 1.1

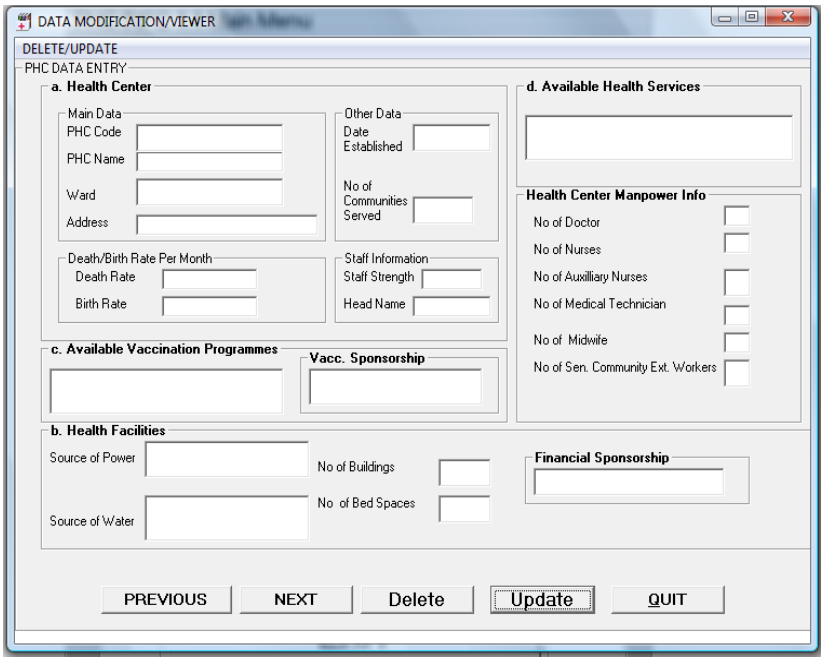


Figure 4. PHC Data viewer form

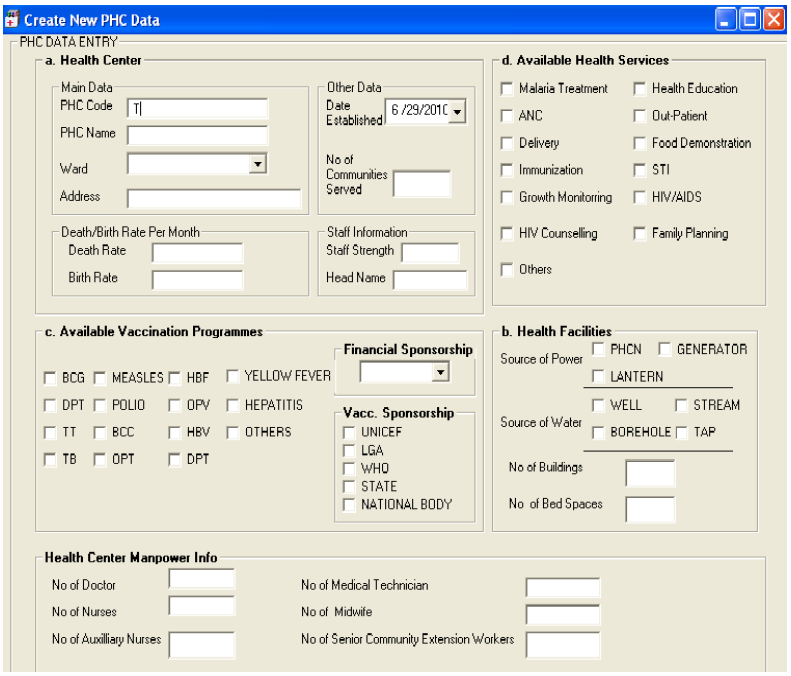


Figure 5. New PHC Data form

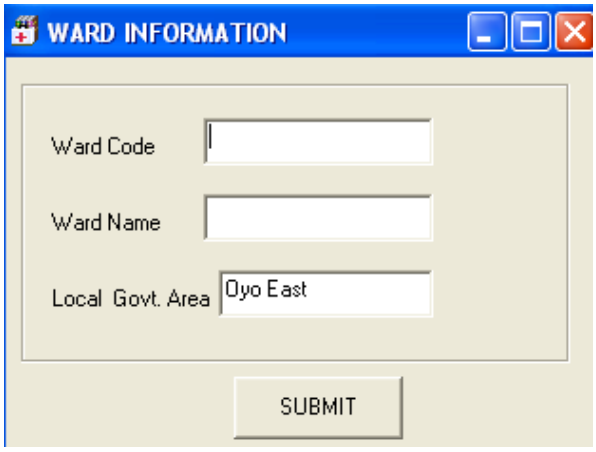


Figure 6. Ward Data form

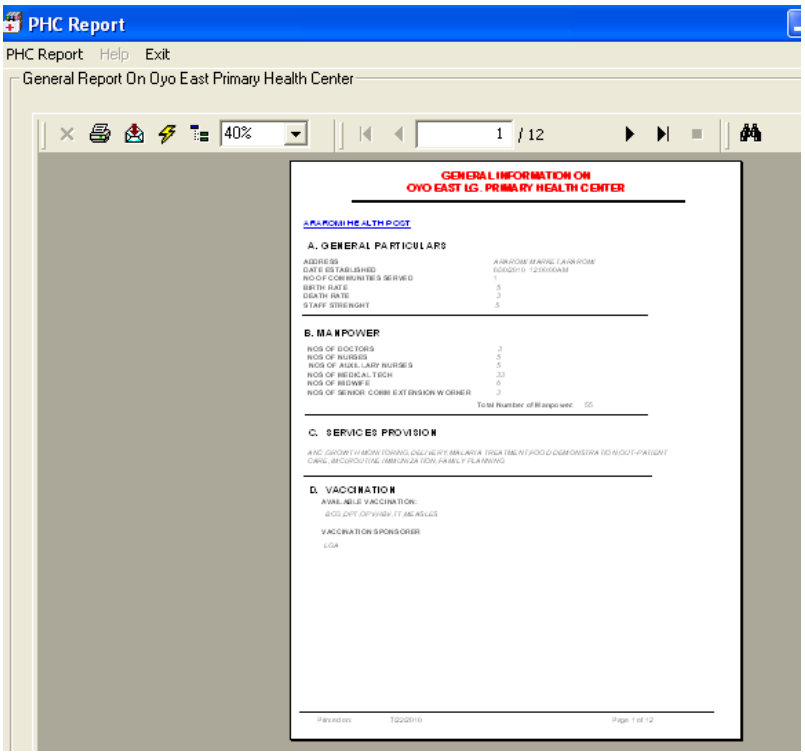


Figure 7. Sample data report form

Discussions

To allow easy handling by qualified as well as low-skill health professionals, simplicity, intuitiveness and stability were the key concepts used in system development for primary health centres in Oyo East Local Government. The system consists of several user interfaces with multiple functionalities including: Data entry, Data Modification, Data searching and Data reporting. The benefits outweighs the initial system of health care delivery in the primary health care centers. A primary health center's relevant information would be available to patients' in terms of facilities, service provisions and personnel to all providers at the point of care and to patients through electronic health record (EHR) systems. The objective of the proposed system was also to improve and enhance the services offered by Primary Health Centers (PHCs) in the study area. The new system developed is PHCINFO 1.1. The PHCINFO 1.1 is a database management system that reveals the extent of healthcare delivery of the primary centres in the study areas respectively. A patient's healthcare need is proportional to the level of healthcare services. When a healthcare does not have the necessary facilities, manpower to accommodate a patient's care needs, then a choice has to be made for an alternative. In the design technique of the PHCINFO 1.1, the system has four authorization modules namely data entry module, data modification module, data searching module and data reporting module. The users except the database manager can gain access to the various modules, where previous records can be read and edited, or new records are entered and submitted to the database for update, or close to exit. However the database manager has access to all the modules including the search module and he also is able to modify records, add new ones, update and searc

Conclusion

Patients seek quality health care but cannot purchase it directly on the market. They must instead choose the health center they believe is appropriate from a limited list of possible health centers. PHCINFO 1.1 can effectively and efficiently handle information required for its performance. Data are easily entered into the database and it is possible to generate reports for decision making, statistical reports and for research purposes.

Recommendation

PHCINFO 1.1 designed for primary health care centers in Oyo East Local Government will definitely improve the delivery of health care services in the area. It is therefore recommended that:

1. A periodic system analysis should be carried out in order to accommodate new technological challenges.
2. A proper maintenance culture of the system should also be developed for durability example servicing of the system as at when due
3. There should be back-ups for all necessary data in external hard disks or drives.
4. Staff should undergo training periodically in order to enhance overall productivity.

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