Development of an Electronic-Based Integrated System for Nigeria Health Management Information Systems

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ABSTRACT

The District Health Information System 2 is a flexible, standard Java-based, free, and open-source online software technology that was proposed in this study as a way to merge four current standalone and different Health Information Systems (DHIS2). This Integrated National Health Information System (i-NHIS) was built using the DHIS2 application software, which runs on a web server, supports Java Servlets, and can be accessed via web browsers over the Internet. By combining numerous fragmented, incomprehensible, worthless, and poorly standardized HISs, the outcomes provide advanced knowledge about national healthcare services. It is made up of a variety of data kinds and detailed information that is used to make decisions, measure, and monitor healthcare delivery processes in Nigeria for overall improvement. The proposed i-NHIS provides more trustworthy, accurate, full, and timely information as well as decision-making tools, hence improving the quality of Nigerian healthcare delivery and services.

Keywords: Integrated, standalone, DHIS 2, information, healthcare, application.

INTRODUCTION

Following the domestication of the Alma Ata Declaration in 1978, the country prepared for extensive health-sector reforms, including a primary (grassroots) healthcare approach to providing treatment to its population. The National Health Policy was implemented ten years later during a period marked by four (4) successive national governments (three military and one civilian) [1]. In 1992, the National Health Policy mandated primary health care as the key emphasis, paving the way for the first time in history for the establishment of a coordinated and robust statewide Health Management Information System (HMIS) architecture.

The HMIS was first funded in 2000 as part of the VISION project, a collaboration between Johns Hopkins University in the United States, Engender Health, and other development partners [1]. Later, in 2001, the Federal Ministry of Health and the VISION program established Nigeria's first (proprietary DOS-based) computer-based National HIS (named Health Information for Action, HIFA), which was piloted in three states: Bauchi, Oyo, and Enugu. Despite this, there were various issues with the execution, including the utilization of big datasets, poor facility management, insufficient interconnectivity, and multiple concurrent systems. Health information management systems are discussed as an integrated platform approach in this research.

LITERATURE REVIEW

The Health System of Nigeria

In most developing countries, such as Nigeria, effective management and use of health information is increasingly being recognized as a strategic resource for health reform initiatives, with a focus on decentralization of service management and health delivery systems, integration of disparate health programs, and, most importantly, building an evidence-based decision-making culture. This growing awareness is helping to attract new institutional and technology players to the field of Health Information Systems (HIS), which is changing the environment daily [3] [4].

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The demand for more integrated as well as specific and granular information to provide aggregate statistics for purposes of upward reporting to accommodate diverse information such as cross-cutting indicators taking inputs from multiple systems [5] [6] is a clear trend in the changing landscape of HIS. The Millennium Development Goals (MDGs) demand this cross-cutting data for monitoring purposes. This entails the use of data warehousing technologies, powerful Business Intelligence (BI) capabilities (such as mapping), and a stronger national and global mandate toward integration to integrate various types of systems (such as patient and facility-based data), health programs, and their respective information systems (such as HIV and ANC programs) through the use of data warehousing technologies, powerful Business Intelligence (BI) capabilities (such as mapping), and a stronger national and global mandate towards integration. Mobile technologies enabled data reporting from previously unreachable outreach areas, and cloud computing enabled a single central server-based deployment for a province or a nation, which has redefined the demand and supply for integrated information, standard reporting practices, capacity development needs, and the cost-effectiveness of HIS deployments [7] [8] [9].

Applications of Integrated National Health Information System

The major applications of i-NHISs are discussed as follows:

A Social System Perspective

The application of a social system viewpoint to information systems began in the early 1980s, with a focus on the social environment and its relationship to the technical. Kling and Scacchi (1982) coined the term "web model" to describe how large information systems are likely to be linked to the framework via a complicated web of links, as well as why. This is in contrast to the discrete-entity paradigm, which represents the widely held belief that information systems are unbiased, collective technological systems [10] [11].

A social systems perspective is especially important for understanding HIS in developing countries, which are already embedded in and continue to evolve within a complex web of political, social, institutional, and cultural relationships resulting from the interaction of technologies and various actors (such as international donors, ministry officials, vendors, infrastructure providers). HIS reflects the healthcare system's make-up, which consists of several more or less autonomous, interconnected entities coexisting in peace and/or conflict. People, computers, paper, decision-making management, procedures, and institutions make up Health Information Systems, which have all of the dynamics of a social system [4] [8].

In developing nations, health information systems employ tens of thousands of healthcare workers who are responsible for routinely registering, collecting, compiling, and reporting large volumes of data in a variety of formats. Different people analyze and use data and information in a variety of ways to make informed decisions and improve health service delivery [12] [13].

Transition from Standalone to Integrated Health System

The enterprise architecture of the overall health system is made up of multiple enterprise architectures, each dealing with a specific business area such as medicines, logistics, management, laboratories, HIV/AIDS antiretroviral treatment, and hospitals. Similarly, enterprises can be characterized in terms of the various organizational units that make up the health system (for example, dispensaries, Sub-centres, primary health care facilities, and district hospitals) [14]. Other types of businesses or systems are built on service functions and logistics (laboratories, drug distribution, or ambulance services), or they can span many administrative and management levels (health facility, sub-district, district, or state). The health system, which is considered an enterprise, is made up of several firms and even enterprises of enterprises, or systems of systems [11][15].

To begin, determine and define the enterprise, business, or functional area on which to concentrate your efforts. Second, by concentrating on the information provided and how it is used to enhance healthcare management. This is how non-essential parts, such as multiple production systems, can be hidden. However, from a historical perspective, establishing such clarity in practice is both technically and institutionally complicated [8] [9].

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Architecture to Support Decision-making and Management

Various scholars and managers have recognized fragmentation and lack of coordination of health information as the key issue influencing its usage and utility. Each health service, health program, project, or initiative prefers to structure its reporting systems in its way, frequently blind to what already exists, whether the data they seek is being collected under a different name or another program. These distinct architectures for each sub-system will not always result in sub-system integration.

The mapping of present processes and information handling techniques is a common difficulty with information system design methodologies. To some extent, it is necessary to concentrate on and preserve present habits that are not conducive to innovation. As a result, it is necessary to first consider the perspective of the entire and overall health system as a starting point, and then to replicate this perspective at every echelon of healthcare services, from the national and state levels to the district, sub-district, and health facility levels [4] [9].

The rapid development of the Internet and mobile infrastructure has resulted in the creation and implementation of new computerized and mobile-based information systems. The problem emerges because the current computerization process merely replicates the previous scenario of fragmentation and poor coordination, albeit by wiring it up in the computer infrastructure rather than putting it in stone. To avoid this, a design approach based on information utilization at all levels of management is required, as well as important information to enable coordination and decision-making processes [6].

A data warehouse for health management, in general, contains aggregate data and indicators from multiple production or transaction systems, such as medical records, human resources, logistics, finances, and lab. While the HMIS as a concept can be viewed as a stand-alone system, the data warehouse is often viewed as a central database component of a larger system structure. Paper-based data sources could be used for both the data warehouse and the standard HMIS. Whereas the HMIS is normally represented by its specific paper forms, the data warehouse would incorporate data taken from a variety of paper forms, including those from different health programs, and so maybe viewed as a shared resource for the programs and units supplying the data [4] [13].

New Trends in Integrated Health Information System

IHIS is concerned with the provision and use of data and information to support decision-making at all levels of the healthcare system. Various specialized components of the HIS, including electronic medical records systems, laboratory systems, logistics systems, and HMIS, are included in this integrated framework. These components must communicate by sharing data and sending and receiving data from one or more systems, all by a predetermined plan or design. The many sub-systems and their interactions must be situated or assigned a role and understood as part of the overall design of an integrated framework [11] [9].

The fast expansion of the Internet and mobile telephone infrastructures has recently resulted in the emergence of a growing number of new HIS that were unthinkable only a few years ago. However, the challenges of managing and coordinating infrastructures come hand in hand with these opportunities. These difficulties increase the complexity of the systems tremendously, making it increasingly difficult for health authorities to prepare for the future. Different approaches to good design within an integrated HIS framework, which may be operationalized through the idea of IHIA, is a method for managing this growing complexity [6] [11]. The majority of hospital systems have the following features:

Input: Ailing patients entering the hospital.

Throughput: The various procedures that a patient goes through while in the hospital, include registration, billing, laboratory, Outpatient Department (OPD), Inpatient Department (IPD), and other more specialized procedures like blood bank and surgery.

Output: Cured patient leaving the hospital (as one of the outputs).

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Feedback: This characteristic includes: I direct feedback: patients' opinions on the effectiveness of hospital services, which may lead to the hiring of more specialist doctors (new inputs) or better management to advance the quality of services (throughput); and (ii) indirect feedback: cure rates of the hospital are considered, which, if lower than other hospitals, may lead to changes such as re-defining inputs (strengthening referral process to the hospital) or re-designing inputs (redesigning the hospital) [16].

Though the preceding phases portray a system as simplistic and linear, this is done on purpose to aid comprehension. Each aspect of the system can be enlarged in real-world scenarios, and social interactions can be included to give a rich image of the system [15][16].

METHODOLOGY

Databases, People, Data Capturing Machines, and the Health System, as well as network links, make up the structure of the integrated National Health Information System is created. The work's main goal is to develop and combine separate health information subsystems. Throughout Nigeria's geopolitical lines, the numerous subsystems have been categorized into four separate diseases and health information. As illustrated in Fig. 1, the National Health Information Centre in Abuja has four (4) Web Servers for Health Information that are interconnected to deliver the i-NHIS to properly manage the pool of data and information.

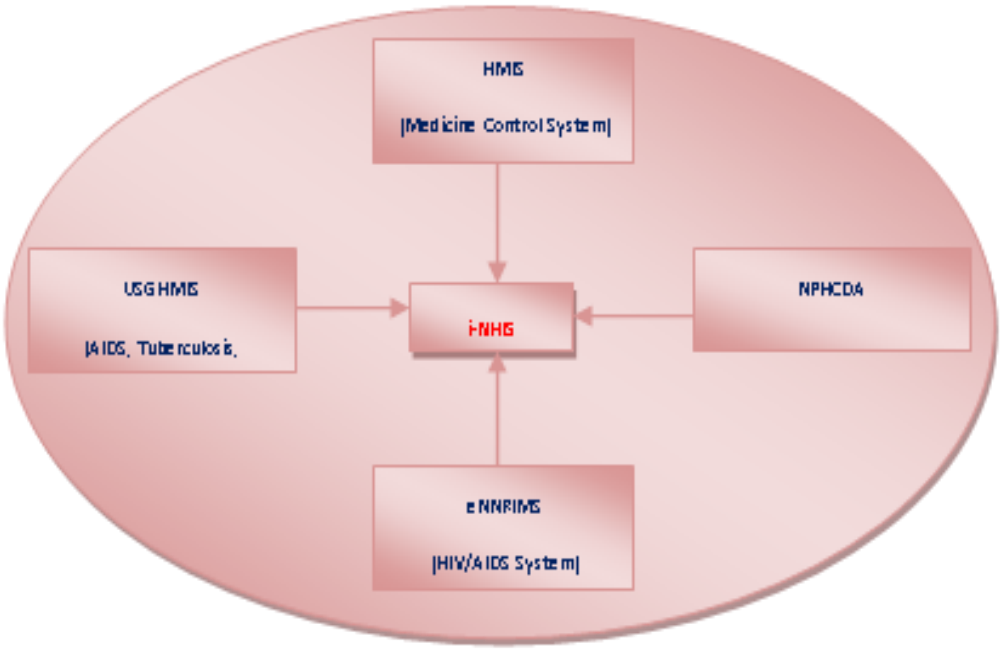

Fig. 1. An integrated National Health Information Management System.

The details of health information contained in the database of i-NHIS are shown in Table 1.

Table 1. Integrated databases of the proposed Health Information System.

S/no	Database
1	Malaria
2	HIV/AIDS
3	Nutrition
4	Tuberculosis (TB)
5	Medicine administration and control
6	Immunization (Measles, Polio, Meningitis)
7	Family planning (Reproductive health, Birth, Antenatal care, reporting rate)

Table 1 shows the steps for generating complete health information to facilitate overlapping, minimizing duplication, and sharing of data across many HISs. As shown in Table 2, the amount of data/information complexity of various levels of the integrated HIS is thoroughly documented from 1 to 4 and vice versa.

Table 2. Structure of the proposed Integrated National Health Information System.

Level of HIS	Function	Categories of Health Data
1	Community-based records of health services	-VHW/TBA -Monthly Data Summary -Community profiles.
2	State HIS (SHIS)	-Details of state records (identification) -Health services data -Profiles of state -integration of level 1 data captured.
3	National HIS	-Details of state records (identification) -Health service data -Profiles of state -Integration of level 2 data captured.
4	Integrated National Health Information System	-Details of National health records -Integrates all independent health services data -Unified database for National health records -National Profiles -Management and maintenance.

Table 2 shows how the complexity of the data generated ranges from 1 to 4 and vice versa. Similarly, each level of responsibility for specific data collection across the information channel reports to the National Head Office, which compiles and prepares a snapshot of the complete health management system. The entire health system's activities are decentralized. A suggested integrated health system, once again, has centralized resource management.

RESULTS

The capability and throughput of the DHIS 2 based health information system integration solution were calculated using two tests in this article. A visual sequence is used to compare the outcomes of heritage and proposed health information systems, and requests are processed. Webpagetest (http://www.webpagetest.org) was chosen as the real-time testing tool for this project. Figure 2 depicts the visual progression of both health information systems' web application servers.

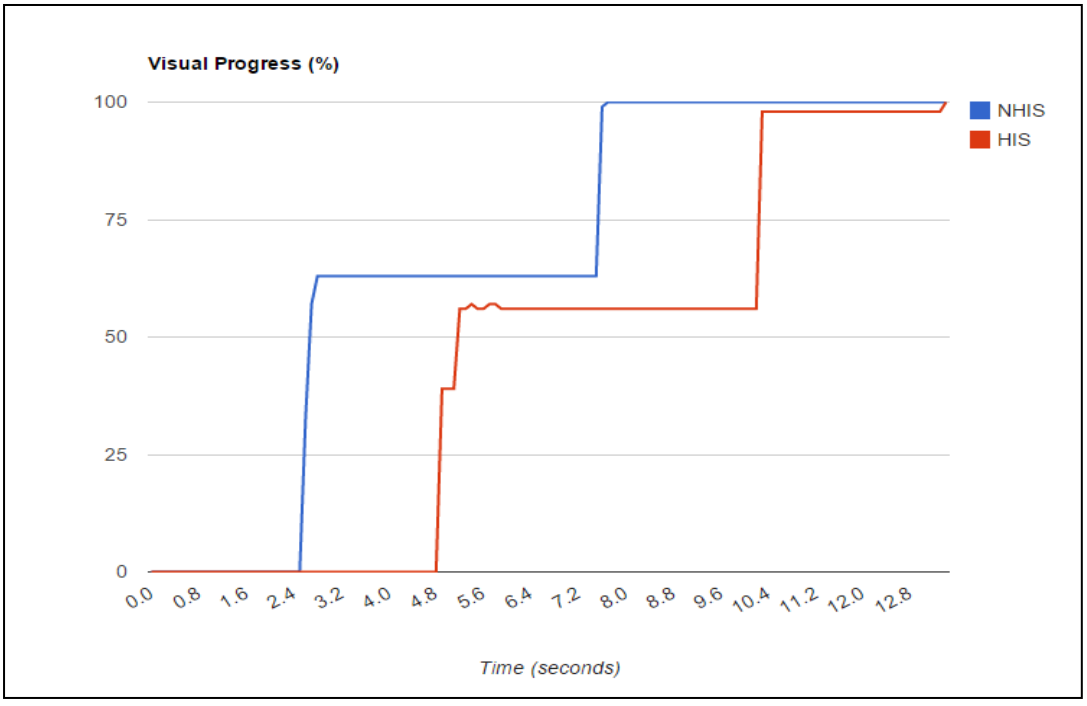

Fig. 2. Web Server visual progression compared.

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The visual progression of Web Server, as shown in Fig. 2, indicates the percentage of Web page portions displayed as time progresses (seconds). It was discovered that due to well-organized information and data relationships, the visual progress index for iNHIS is superior to HIS. Figure 3 shows the total number of requests handled by various web servers throughout the assessment.

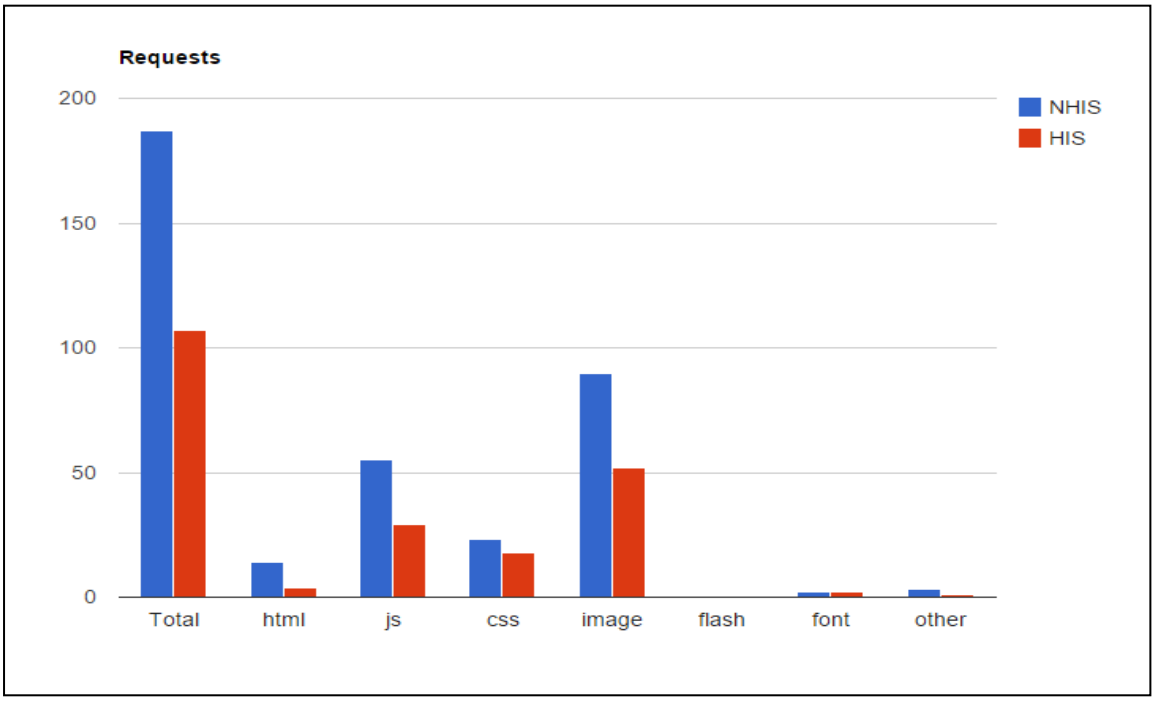

Fig. 3. Amount of request types compared.

The number of request types accommodated by the various systems varies greatly with the traffic generated, as shown in Fig. 3, including HTML, js, CSS, and image. Because of the extensive diversity of data sources and requests flooding the integrated system, the i-NHIS performed twice as well as the older health information system. In addition, the DHIS 2 integration solution provides improved resource sharing techniques as well as simple data types and structures.

CONCLUSION

The enormous benefits of implementing an Integrated National Health Information System in Nigeria's health sector were outlined in this article. These include providing all-inclusive facts and information in a qualitative and timely manner for decision-making. Monitoring and tracking healthcare coverage and processes for outright improvements have a high capability. The DHIS2 databases are a useful tool since they offer many input channels for the system, including mobile devices. At the bottom of the data collecting hierarchy, data integrity has improved. The study suggests approaches to collaborate on the construction of a national health information system with mobile and telecommunication providers. To evolve in a flexible framework, health authorities-built systems must comprehend the various components of the HIS and roles after integration. However, future updates to a health system must be planned for seamless integration into the historical health information system.

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