Integration of Health Data using Enterprise Service Bus

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***Abstract*—The Department of Health in South Africa has a challenge in the healthcare service delivery monitoring and performance due to the non-existence of a functional health information system capable to produce the real time information. The health system is characterized by lack of coordination and automation, dominance of the manual and lack of interoperability between the existing health information systems. The government has invested considerable in the acquisition of software applications that did not generate expected outcomes. The research proposes a framework as a roadmap to guide the design of the integrated national health patient based information system.**

***Index Terms*— Enterprise Service Bus, HL7, SOA, EHR, HIS, DHIS, NHIMS**

I. INTRODUCTION

The existing solutions on health information system in South Africa do not support patient mobility and not enabled to interface transversally with other systems used in the health sector [1]. A patient is able to duplicate the collection of medication using different clinics or hospitals thereby disadvantaging the other patients. A patient moving from one area to the other will have no central clinical file; instead a clinical file is opened based on the new diagnosis by the doctor.

The lack of reliable health information system is an obstacle to effective health services in South Africa. The National Health Information System of South Africa (NHISSA) committee found that existing systems were fragmented and incompatible, uncoordinated and not comprehensive, software and hardware incompatible and not user friendly, manually driven systems, and inadequate analysis interpretation and use of data localised [2]. The healthcare system in South Africa is a very complex one, with a number of challenges that led to a multitude of eHealth systems and solutions. However, the solutions are provided and function in an isolated compartments of the healthcare system [3]. An integrated all-inclusive solution is required, for the benefits in the improvement of healthcare and a continuum of care as a whole [3]. The Department of Health in South Africa established the District Health Information System (DHIS) in 1997 as an application system to track health service delivery in the public health sector. The system incrementally over decade was able to generate data for planning, monitoring and reporting and serves as an important component in the future Health Management Information System (HMIS) [4]. The department of health has recently introduced the District Health Management Information System (DHMIS) which is inclusive and synonymous with the DHIS software solution although much broader, since it includes people, policies, hardware, software, networks and datasets.

The DHMIS focus on Health Information Coordination and Leadership, Indicators, Data Management, Data Security, Data Analysis and Information System Resources [4]. The DHMIS will serve as a key component to the design of a comprehensive National Health Management Information System (NHMIS), which a need already exists in the health sector to integrate data components from Population-based information; Health services based information, Health resources records; vital registration data and Transversal (government-wide) support systems. The integrated system will collaborate with Home Affairs Systems as a custodian of the civil registration system; Statistics South Africa as a custodian for all official statistics, including census data and private health sector data [4].

Integration of data, which is a process to combine data from different sources into a unified view, has become a serious problem as the volume of data and rate of information exchange increases. The ultimate data integration system allows loose coupling among heterogeneous data sources and access management while maintaining exchange of data [5]. The research is an attempt to deal with integration of health data challenges by

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suggesting a customizable integration architecture that meets clinical outcomes. The research addresses integration challenges in generating Electronic Health Records (EHR) by using the Enterprise Service Bus (ESB). The research focus on the health information system which integrates data collection, processing, reporting, and use of the information necessary for improving health service effectiveness and efficiency through better management at all levels of health service [4].

The health service data regarding the patient is stored in a variety of places and formats for administrative and financial purposes rather than clinical purposes [6]. The dynamic setting in our days, require information and communication technologies (ICT) to take a leading role and impact on the practices of healthcare [7]. In South Africa the legacy of apartheid has made standardization of health data a major problem. The politics of apartheid was deeply inscribed into all bits and pieces of the information systems in which a problem exist in the standard for data collection, due to fragmentation based on race, type of service and the system of homelands [8]. South Africa, through the health department, introduced the Health Information System Program (HISP), starting three pilot districts in Cape Town in 1996, with intention to identify information needs, engage community and local government in designing the system. However, problems arose with tension between standardization and flexibility for localization [8]. The HISP system, did not integrate the data from different sources, but concentrated on standards for primary health care data.

II. EHEALTH

eHealth is a term explained by the World Health Organisation (WHO) as the use of ICT for health [1]. eHealth can be used to track diseases, monitor health, educate students, pursue research or even in treatment of patients. The definition covers a number of domains, including: EHR, DHIS, HIS, Health Informatics, mHealth, Telemedicine, Virtual Healthcare, Health Research, Vital Registration and Health Knowledge Management (HKM) [1]. The department of health in South Africa has initiated a strategy to comply with the development of the National Health Information Management System/ Patient based system.

III. ELECTRONIC HEALTH RECORDS

An Electronic Health Records (EHR) serves as a construction wedge for the design of the Health Information System (HIS) which connect health care facilities at a national level [9]. The EHR is basically the record of an individual's health electronic data stored and exchanged through a secured system in a digital form [9]. The use of the EHR systems enable the medical professionals to exchange data electronically, yielding cost and the quality of health care benefits, however, the exploratory security analysis performed expose the system to common code level and design vulnerabilities [10]. The system provides patient identity or the billing information, and audit trail of transactions occurring. The systems are used to document care of patients, including prescribed medications, immunization history, laboratory test results, allergies, radiology, images, treatment, and other healthcare notes [11].

The focus of the research is on the creation of the National Health Information System (NHIS) of South Africa, which will be a nationwide infrastructure for sharing patient electronic health records (EHR), where public hospitals, private and university hospitals will all connect to for daily feeds of their patients EHRs [12]. The goal being to integrate the information systems from diverse health sources and administrations like hospitals, laboratories, pharmacies, physicians and government agencies within the country in order to connect them to the NHIS with standard data formats, and communication protocol [13].

IV. DATA INTEGRATION WITH SERVICE ORIENTED ARCHITECTURE (SOA)

The Service Oriented Architecture (SOA) enables enhancements in delivery of information and sharing of data within the healthcare providers by cutting costs and increases the security of patient data [14]. The healthcare suppliers normally use various systems and devices to provide patient health care in a hospital environment. In other environment, registration is done on a separate system, admission in another, clinical data in another, and if integration do not exist, then there will be other peripheral systems like labs and radiology to deal with for checking results. The researchers [14] discourage the need to share health data between isolated system, and open a discussion for SOA architecture in healthcare with interoperability between systems that perform variety of tasks in an integrated health systems. Healthcare organizations need to process patient information by synchronising data between various system with interoperability [14].

V. KEY CHALLENGES IN THE HEALTH SECTOR

The health system in South Africa wants to make better use of the data captured to improve service delivery provision and clinical outcome. The problem is existing data sources are not integrated, but work in isolation. The other matter is on technical issues and legal matters pertaining to data integration, data quality, data security and privacy in health data usage. In many clinical and hospital settings in South Africa, existing Health Information Systems (HIS) consists of silos of paper based or electronic data that is poorly fragmented and of poor quality. Even the advanced technology enablers like mobile devices, phone devices, personal computers did little to remove these threats [15]. The capacity of health professionals to share information across all discipline is badly organised, it

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takes time to acquire accurate information. Information is not readily available to clinicians when needed most, gathering the information is time-consuming and expensive, and delays are caused for decision making and care of the patient [15].

The HIS has been designed for supporting the administrative and logistical workflows, and the scope of the application is very limited. The system do not satisfy the need for the medical data procedures and clinical investigations [16]. The research proposes the integration of the health data systems through an Enterprise Service Bus (ESB) as a reasonable strategy to unify all data sources. The government invested financially in the procurement of the Health ICT solutions, Health Information Systems, Electronic Health Records, but the systems do not meet the business requirements in the health sector, such rendering the healthcare system incapable to deliver required service [1].

VI. RESEARCH DESIGN

The main purpose of the research is to determine the software architecture that can be applied to integrate the health data sources into an application to support knowledge sharing among the medical institutions in South Africa. The research addresses the main research question: How can health data sources be integrated? In order to address the main research question, the research addresses the following sub-questions: What is the existing architecture for the health data integration in South Africa? Does the existing health data tool provide service and clinical outcome?

The research takes the user centred application development approach during design and development phase of the architecture [17]. The research also uses scoping review methodological analysis to synthesize evidence from published papers in academic journals and conference proceedings. The following search engines were used: Association for Computing Machinery (ACM), EbscoHost Premier Package, Emerald Management Xtra, IEEE Xplore Digital Library, IOPscience and National Research Foundation (NRF) Databases.The following keywords in table 1 are used as search parameters:

Table 1: Search Parameters

Enterprise Service Bus
HL7 Standards
SOA -Service Oriented Architecture
HIS – Health Information Systems
DHIS – District Health Information Systems
NHIMS – National Health Information System
EHR – Electronic Health Records
e-Health Care
Data Integration
Heterogeneous Data Sources
Interoperability in healthcare systems
Information integration in the health sector

VII. RESEARCH RESULTS

The implementation of eHealth in South Africa is funded within the provincial and municipal budgets, which caused inequity of eHealth, as the financial investment varies. The deployment revealed disparities in using ICT as an enabler to healthcare service delivery. Throughout the years, since 1994, the department of health reported uncoordinated investment in eHealth, with no tangible benefits and return on the investment [1]. The landscape analysis of HIS development in South Africa is reported at stage 3, based on categorization of five stages of eHealth maturity levels which are: Stage 1 - paper-based systems for collecting district health indicators, Stage 2 - optimization of paper systems through simplifying indicators and reducing duplication, Stage 3 - migration of traditional district health information systems to electronic storage and reporting, Stage 4 - introduction of operational ICT systems as a source of data for HIS, Stage 5 - a fully comprehensive and integrated national HIS. Some of the provinces are reported to be at stage 2, others have advanced to stage 4, while some regions or districts are between stage 1, 2 and 3.

South Africa needs to develop and implement the integrated national health information systems which facilitate healthcare delivery in all healthcare institutions (private and public) in order to advance to stage 4 and stage 5.In 1996, the department of health decentralized the implementation of the National Health Information System to provinces; as a result, several disparate systems have been implemented which vary in their architecture, usability, workflows, etc., as indicated in table 2 below [1]. The systems are not able to communicate with each other (no interoperability) and are not integrated.

Telemedicine was once recognized to be effective to overcome rural health challenges, however, the project became a failure due to lack of capacity and provinces reluctant to manage the project. mHealth which is a mobile technology can provide an opportunity that can also revolutionize the health care system in South Africa. The current projects include the designed systems to collect data for HIV counseling and testing.

The South African Bureau of standards (SABS) localized and adopted two standards for eHealth regulations which are ISO/TS 18308:2004 (SANS18308 Health Informatics - Requirement for an EHR Architecture) and ISO/TR 20514:2005 (SANS 20514 Health informatics - EHR – Definition, scope and context). Other standards are near completion by respective bodies such as SABS and Private Healthcare Information Standards Committee (PHISC) which focus on collaboration in the eHealth standards in the country [1].

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Table 2: Patient Management/Hospital Information Systems currently deployed in public sector facilities in South Africa

Province	Patient Management/Hospital Information System in use
Eastern Cape	Delta 9
Free State	Meditech ;PADS
Gauteng	Medicorn, Soarian MedSuite, PALS, Pro-Clin, ReMED
Kwazulu-Natal	Medicorn
Limpopo	Medicorn
Mpumalanga	PAAB
North West	PAAB
Northern Cape	Nootroclin
Western Cape	Clinicorn, Delta 9, PHCIS, JAC Pharmacy

The eHealth strategy report indicates that South Africa do not have the High Level Seven (HL7) local chapter which is an international authority standard for interoperability of HIS. The department of health has commissioned a sub-committee NHIS/SA to focus on the development of the guideline for the unique identification of patients [1].

VIII. PROPOSED ARCHITECTURE

The research takes advantage of SOA to propose an integration architecture which will serve as a platform in an information system based on HL7 standards to help software developers build an integrated health information system application [18]. The architecture set integrated services for data normalization, security, auditing and business processes with a full spectrum of healthcare institutions.

SOA technology help integrate heterogeneous systems, e.g. EHR, HIS, DHIS, etc. as it offers data bridge between incompatible systems. The architecture is based on the SOA technology in order to bundle functionalities as a collection of interoperable services within multiple separate systems [19]. The architecture in figure 1 below support transformation of the business as an approach to loosely coupled, protocol independent interlinked services which are independent of each other. The service consumer is connected through the application tier interface to the system management for authentication. A service is invoked through a service consumer by sending a request to the service provider seating at a remote machine, whereby the service provider respond to the request through the service response. The entire request invoked by the service consumer need to be authenticated for security purposes through system management tasks. The Enterprise Service Bus (ESB) serves as a backbone and enabler for connecting and integrating the service consumer to the service provider. The ESB delivers important infrastructure to create the service oriented architecture.

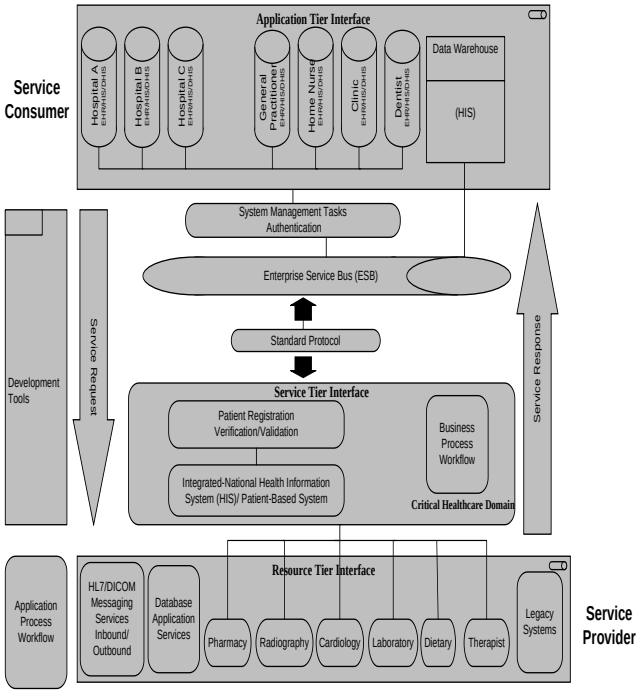

Fig 1: SOA Framework for Integrated Health System-Patient Based

IX. CONCLUSION

The analyses of the healthcare system in South Africa, shows that most provinces still operate at stage 2 and 3, as categorized in the research results. The health institutions operate manually or in other cases not fully automated with limited integrated functions. The department operates in a complicated system with inaccurate results. The SOA paradigm provides autonomous services, where health institutions are connected to each other and are able to use patient based integrated system.

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