An Analysis of The Design Framework of the Radiology Information System and Hospital Management Information System Used in Selected Public Hospitals in Uasin Gishu County

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Abstract:- To deliver better services at all levels of a health care system, information exchange is crucial. The patient, the doctors, and the organization need to have access to the patient data. Access to the right information and at the right time is crucial to improved patient care in any health facility. Patient history and radiological data must be available whenever and wherever they are needed hence this requires the integration of information from several systems within a healthcare setup. The main purpose of integrating health information systems is more like modification of business practices in an organization, which implies employing faster or simple working methods to enable more efficient and effective organization. The study's main objective was to assess the status of the design framework of the RIS and HMIS in the selected public hospitals in Uasin Gishu County. These hospitals are beneficiaries of the Managed Equipment Service Project by the Kenyan Government through the Ministry of Health. The selected hospitals are Ziwa Subcounty Hospital, Burn Forest Subcounty Hospital, Moi Teaching, and Referral Hospital. The study aimed at developing a framework for integration RIS and HMIS. The study carried out an all-inclusive participatory investigation into ways of integrating RIS and HMIS in the selected public hospitals in Uasin Gishu County by administering questionnaires. Data from the questionnaires was analyzed using statistical package for social sciences (SPSS v 20) and the findings show that both RIS and HMIS used in selected hospital exist as independent systems that do not exchange data. The study recommended an evaluation of both RIS and HMIS used in the selected public hospitals in Uasin Gishu County.

I. INTRODUCTION

Information system is defined as the socio-technical subsystem of an institution, which comprises of all information processing as well as the associated human or technical actors in their respective information processing roles(Boell & Cecez-Kecmanovic, 2015). A health information system basically consists of a particular group and the corresponding resources whose main goal is to improve health. This contains attempts to influence methods of improving healthcare activities. Health information provides a cornerstone within which all the decisions in a healthcare organization are made. These decisions could be clinical, at the bedside or a national government level(Hovenga & Grain, 2013).

The WHO has a framework that outlines the health system in terms of six core components or "building blocks" namely; Services delivery, health workforce, health information system, access to essential medicines, financing and leadership/ governance. These building blocks are interdependent and must interact synergistically to produce a positive impact on health outcomes. This paper tackles one of the building blocks, that is health information systems(World Health Organization, 2015).

In August 2010, Kenyans voters approved a new constitution in a referendum, marking the beginning of devolution as the latest round of decentralization in Kenya. The new constitution introduced a devolved system of government in which many of the national government services were delegated to the forty-seven county governments. The newly created counties were based on the 1992 district framework. The main aim of devolution is to enhance democratic and explicable source of power. It should also promote national unity by acknowledging diversity in the society and awarding powers to the people. Devolution should also be able to give room for participation of the people in the

exercise of the powers of the state and in making decisions affecting them(Kimathi, 2017).

The County government structure as defined in article 176 of the Kenyan constitution provides for County government which comprise of the County Assembly and the County Executive. Every County is permitted to devolve its functions according to societal needs in that particular county (Transparency International Kenya, 2014). The constitution has divided the healthcare responsibilities between the County and national government so as to permit the implementation rights that are associated with health. The Kenyan Constitution through the Fourth Schedule indicates ways in which services in the county or national governments are to provide. The national government is mandated with providing health-related policies, technical assistance to county health facilities and management of national referral health facilities whereas the delivery of essential health services is assigned to county governments (Kimathi, 2017).

To support the devolution of healthcare services, the Government of Kenya initiated the Managed Equipment Service project (MES) in 2016. The project refers to a flexible, long-term contractual arrangement that involves outsourcing the provision of specialized, modern medical technology and equipment to private sector service providers. It comprises a 7-year contract between the Ministry of Health and various contractors for the supply of equipment to 98 hospitals comprising of two health facilities in each of the 47 Counties as well as four health facilities under the management of the National Government. The equipment supplied included; Radiology equipment, Theatre, Laboratory, ICU and Renal equipment. The Radiology Equipment includes a digital x-ray machine supported by the Radiology Information system for managing patient data and the subsequent images(Cynthia Olotch, 2017).

Most radiology departments, there are at least five separate information system in use. Picture archiving and Communication System (PACS), Radiology Information System (RIS), a Hospital Information System (HIS) are the most commonly used systems,(Honeyman, 1999). A RIS makes it easy for radiological examinations to be scheduled. It allows patient information to be traced while at the same time enabling online reporting by radiologist. HIS on the other hands assists hospital staff to complete administrative duties such as patient registration, discharge, and billing. PACS is a system that has the capability of capturing radiological images, storage, processing, and distribution of radiographic image data(Mohd-Nor, 2011).

Most hospitals in Kenya use different information systems in a different care setting, making it difficult to safely communicate information. These independent systems also maintain their own vertical and uncoordinated reporting system making it impossible to even trace a patient healthcare journey(Njeri & Matende, 2014). If systems are not integrated into a healthcare set up, then the results are duplicate data entry tasks, inconsistency, and inadequate functionality. Inaccurate data entry makes it difficult to find historical studies. It also makes it almost impossible to match a report with its associated study(Honeyman, 1999).

To look into the problems mentioned above the study assessed the design framework RIS and HMIS in the selected public hospitals in Uasin Gishu County to design a comprehensive framework to integrate them.

❖ *Definition of Operational Terms*

➢ *Information Systems*

Is defined as the socio-technical subsystem of an institution, which comprises of all information processing as well as the associated human or technical actors in their respective information processing roles(Boell & Cecez-Kecmanovic, 2015).

➢ *Hospital Information Systems*

It's an information system designed to specifically manage the administrative, financial and clinical aspects of hospitals and healthcare facilities. They are regarded as crucial channels within which the delivery of healthcare services in hospitals and different types of medical institutions relies on. (Khalifa & Alswailem, 2015)

➢ *Hospital Management Information Systems*

HMIS is a system that facilitates general billing, maintenance of hospital equipment and recording information related to patient's diagnosis among other functions(Abdulla et al., 2017).

➢ *Radiology Information System*

Is an information system based mostly in radiology departments of most hospitals. It's used for patient registration, examinations scheduling and interpretation of radiological images by radiologists'. In some cases, RIS provides management information and specifically helps in the collection of revenue related information. (Ratib, Swiernik, & McCoy, 2003)

➢ *Picture Archiving and Communication System*

Is a system that has the capabilities of capturing radiological images, storage, processing, and distribution of radiographic image data PACS eliminates the old habit of manually filing, retrieval, and transportation of radiological films. Images are transferred electrically from the modalities to PACS archive server. ((Huang & Demiris, 2005).

II. LITERATURE REVIEW

According to (Abdulla et al., 2017), the architectural design of HMIS is classified according to the number of functions that can be supported by it. HMIS systems suitable for small to medium level hospital consists of only one database that stores all patient's related data. The network architecture of such systems is client-server with a centralized database. They include one mainframe server connected to multiple terminals or workstations. In this kind of architecture, application components: patient registration; Accounting and Finance; Billing; Radiology; Pharmacy; Stores are on the framework to be accessed by the terminals.

According to (Sibarani, 2012), to integrate RIS and HMIS, we look at the following technical design component; System architecture, Data standards, and interoperability.

➢ *System Architecture*

Information system architectures are categorized into three groups: Hardware architecture; Software architecture and Enterprise architecture. Software architecture is considered the backbone of Information system architecture as its concerned with how programs and application components are internally built. It comprises of fundamental structures that make up software elements, their properties and the relationships between the elements. Hardware architecture refers to the identification of the system's physical components and how their interrelationships. It's an important component of an information system architecture as it provides software designers with relevant information needed for software development and integration. Enterprise architecture, on the other hand, applies principles and guidelines that help organizations in business, information processing and technological changes necessary to execute strategies(Vasconcelos, Sousa, & Tribolet, 2003).

➢ *Data Standards and Interoperability*

To use and share data within multiple systems, the data must be built upon common words, structure, and organization. The common words in which data is built upon are data elements and terminology. This requirement is what is referred to as interoperability(Brooks, Health, Healthcare, & Standards, 2010).

Lack of shared standards for data collection in a health institution means that the same data are often collected and reported many times among departments. At the same time, there are gaps where important data do not get reported. This inconsistency in definition and procedure creates inefficiency (Chilundo *et al*, 2004).

Regardless of the technology, for integration between systems to happen application component has to communicate. There must be an agreement about the syntax and semantics of data and messages that are to be exchanged. The common standard used in the integration of RIS and HMIS are HL7 and DICOM(Abdulla et al., 2017).

DICOM is the international standard for medical images and related information. Implemented in almost every radiology imaging device, it defines the formats for medical images that can be exchanged with the data and qualities necessary for clinical use. (Noumeir & Pambrun, 2012). The DICOM standard makes it possible for images from different imaging modalities to be distributed over an internet network to distant viewing workstations and a central archive almost seamlessly(Robertson & Saveraid, 2008).

The HL7 refers to a set of international standards for the transfer of clinical and administrative data between software applications used by various healthcare providers. The Standard is produced by the Health Level Seven International and recognized by other standardization bodies like the American National Standards Institute and the International Organization for Standardization (HL7 International, 2016). Level Seven, in this case, refers to the highest level of the International Standards Organization (ISO) communication model for Open Systems Interconnection(OSI). It provides a common language for information exchange and electronic patient records in both externally and internally. (Abdulla et al., 2017)

The OSI is a model reference tool for understanding data communications between any two networked systems. The communication process is divided into seven layers, with each layer performing specific functions to support the layers above it and offer services to the layers below it. The three lowest layers focus on passing traffic through the network to an end system. The top four layers come into play in the end system to complete the process(Simoneau, 2006)

III. METHODS

This study adopted a descriptive research design using a survey method. The study was carried out in selected public hospitals in Uasin Gishu County. These hospitals were Ziwa Subcounty Hospital, Burn Forest Subcounty Hospital, Moi Teaching, and Referral Hospital. They are all beneficiaries of the Managed Equipment Service project(MES) initiated by the Kenyan government in 2016.

The study targeted 195 staff members Ziwa Sub County Hospital, Burn Forest Sub County Hospital, and Moi Teaching and Referral Hospital. The sampling techniques used to select the sample comprised of both purposive sampling and random sampling approaches. To get a representative sample, the study calculated using the 30% formula of Mugenda Mugenda(Mugenda & Mugenda, 2003). Out of the 195 staff member, the sample size was 59.

Data was collected through objectively structured questionnaires. This is because the responses are gathered in a standardized way, so questionnaires are more objective, and generally, it was relatively quick to collect information using a questionnaire.

Descriptive statistics using Frequency tables and charts were used to examine the integration of RIS and HMIS in the selected public hospital in Uasin Gishu County. Data analysis was done using the statistical software SPSS. Data was presented using charts and tables.

The researcher sought and obtained ethical clearance from Moi University/Moi Teaching and Referral Hospital Institutional Research and Ethics Committee (IREC) and the National Commission for Science Technology and Innovation (NACOSTI.

IV. RESULTS

The study sought to assess the status of the design framework of the RIS and HMIS in the selected public hospitals in Uasin Gishu County. The purpose of the questions was to establish if the design framework of the current RIS and HMIS used in the selected hospitals can support information system integration.

To evaluate the interoperability of the existing RIS and HMIS, participants were also asked to indicate if they think the two systems are compliant with the international standards for hospital systems integration, that is DICOM for RIS and HL7 for HMIS. The results show that (25.4%) strongly agree that the RIS is DICOM compliant, whereas (33.9%) agree with the same. Majority of the respondents (37.2%) are not sure if indeed the RIS meets the required standard for integration while (3.4%) disagree. Regarding the HMIS, (3.4%) strongly agree that it meets the required standard for system integration, whereas (15.3%) agree that indeed its HL7 complaint. Again, just as with the RIS design framework, Majority of the respondents are not sure or are undecided on whether the existing HMIS is HL7 complaint representing (72.9%) of the participants. Participants were also asked to indicate if any other systems within the hospital are connected to the HMIS. Majority of the respondent Disagreed (57.6%), whereas (25.4%) of them were undecided. Some participants, (8.5%) strongly agreed that indeed other systems are connected to the HMIS while the same percentage of respondents agreed with the statement.

The findings are tabulated in Table 1.

Sub variable	SA	A	U	DA	SD	Total
There is an existing HMIS in the hospital	27(45.8%)	32(54.2%)	0(0.0%)	0(0.0%)	0(0.0%)	59(100%)
There is an existing RIS in the Hospital	21(35.6%)	34(57.6%	4(6.8%)	0(0.0%)	0(0.0%)	59(100%)
RIS system is only used in the Radiology Department	18(30.5%)	35(59.3%)	6(10.2%)	0(0.0%)	0(0.0%)	59(100%)
HMIS is used in all sections within the hospital	6(10.2%)	9(15.3%)	10(16.9%)	33(55.9%)	0(0.0%)	59(100%)
RIS used in the hospital is DICOM complaint	15(25.4%)	20(33.9%)	22(37.2%)	2(3.4%)	0(0.0%)	59(100%)
HMIS used in the hospital is HL7 complaint	2(3.4%)	9(15.3%)	43(72.9)	5(8.5%)	0(0.0%)	59(100%)
There are other systems in the hospital that are integrated with the HMIS	5(8.5%	5(8.5%)	15(25.4%)	34(57.6%)	0(0.0%)	59(100%)

Table 1:- Design Framework of RIS and HMIS in the selected Hospital.

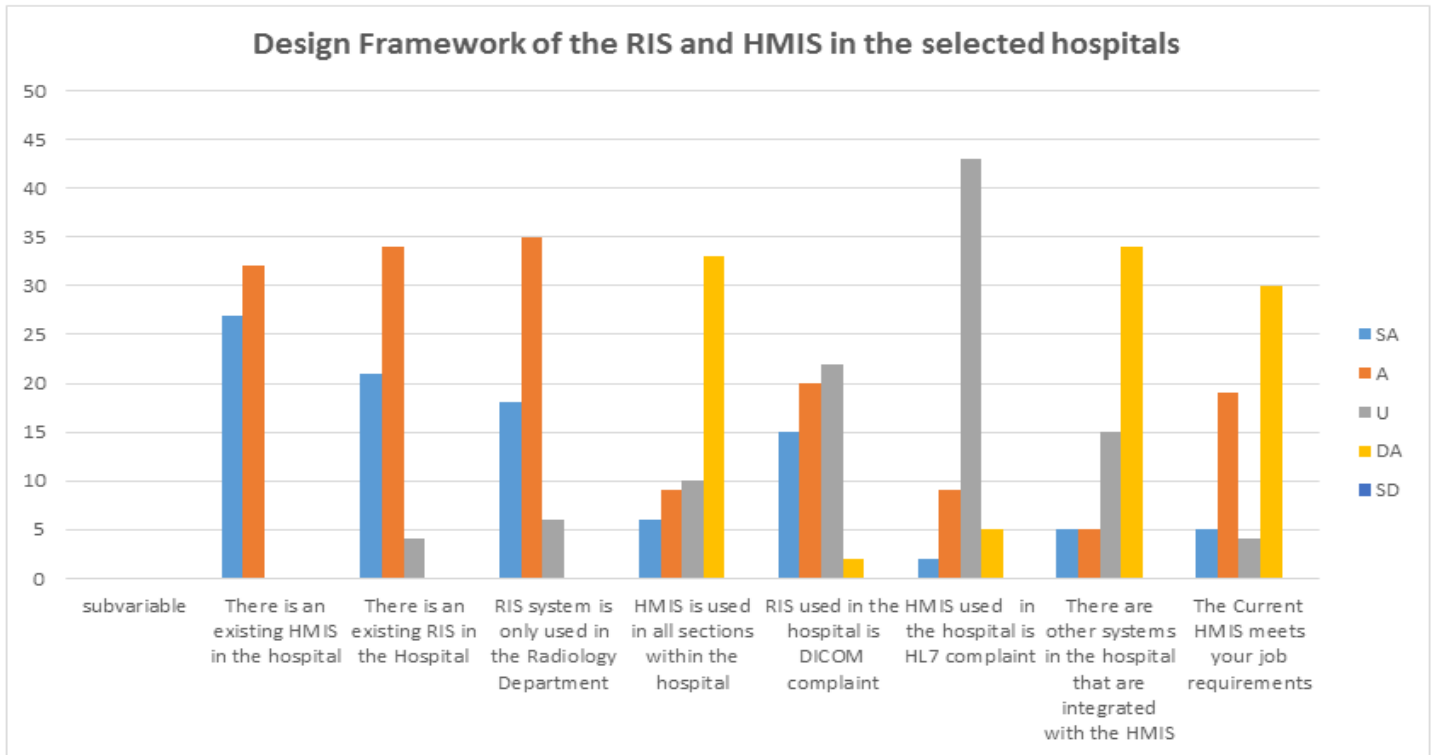The summary of the findings is illustrated in Figure 1.

Fig 1

V. DISCUSSION

The findings indicate that both RIS and HMIS used in the selected hospitals exist as independent systems that do not share or interchange information. This could be because of several reasons, one of them being that they do conform to the required standards for data interchange as indicated by the results. The results, therefore, show that even though the two system exits in the selected hospital, they just do not meet the required data standards for integration. The respondents agreed to the existence of the systems, but they pointed out that the system to do not communicate.

Regardless of the technology, for integration between systems to happen application components have to communicate. The design framework of the systems must be in agreement about the syntax and semantics of data and messages that are to be exchanged. The common standard used in the integration of RIS and HMIS are HL7 and DICOM(Abdulla et al., 2017)

VI. CONCLUSIONS

The study concluded that Information systems used in the healthcare domain should be designed to meet the international standard required for information system integration. To use and share data within multiple systems, the data must be built upon common words, structure, and organization. The common words in which data is built upon are data elements and terminology. This requirement is what is referred to as interoperability(Brooks et al., 2010). If systems are not integrated in a healthcare set up, then the results are duplicate data entry tasks, inconsistency, and inadequate functionality

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