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Interoperability Framework for Electronic Health Records (EHR) Systems for the Tanzanian Government Hospitals in Iringa

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Abstract: Interoperability in healthcare is a requirement for effective communication between healthcare facilities to ensure timely access to up-to-date patient information and medical knowledge to facilitate consistent patient care. The lack of interoperability between health information systems reduces the quality of care provided to patients and wastes resources. Numerous government health facilities in Tanzania have implemented various health information systems, such as GoT-HoMIS, Afya Care, and EHMS, locally. These systems store individual patient medical records and have not yet centralized them. Therefore, patient medical records between these health facilities cannot be exchanged and used among themselves. Interoperability will allow different information systems and organizations to work together. The research finds various challenges facing the interoperability of different electronic health record (EHR) systems hosted locally in Tanzanian government hospitals. Looking at various government interoperability initiatives and developing frameworks that can assist in solving interoperability issues for health information systems, and finally developing an appropriate interoperability framework for the government electronic health record (EHR) systems for the Tanzanian government hospitals. It utilised a descriptive research method whereby descriptive statistics analysis was applied in analyzing the collected data. The result of the analysis, shows that ICT infrastructure and organization processes are among the major challenges that affect EHRs interoperability. Hence, based on the challenges observed, an electronic health records interoperability frameworks developed that will be used as guidance in the interoperability of two or more EHRs.

Keywords: Interoperability; EHRs; EHRs interoperability framework; GoT-HoMIS; AFYACARE

1. INTRODUCTION

Interoperability in the local healthcare systems has not been realised mainly because of the existence of autonomous local healthcare systems used within healthcare organizations, which are developed using various programming languages, tools, and data formats (Suchaiya & Keretho, 2018). Electronic Health Records (EHR) systems can enhance the quality of care, reduce medical costs, and protect patient data, along with reducing costs and errors in medical and official operations in hospitals (Sabooniha et al., 2018).

In the development of EHR systems, a wide range of healthcare applications are built by various vendors and run on different platforms (Zeinali et al., 2019). Government agencies in many countries are actively developi ng interoperability for data exchange and electronic transactio ns to improve public service to their citizens (Suchaiya & Keretho, 2018). Interoperability is generally defined as the ability of two or more different systems or components to exchange and use the exchanged information (Geraci et al., 2017). Standardization of data exchange and information format is very important in achieving interoperability (Alamiri et al., 2018). Interoperable electronic health records (EHR) and other health information systems (HIS) can help enhance healthcare facilities (Jawhari et al., 2016). Health care quality and cost are the most crucial factors in the success of these e-health services (Arche et al., 2021).

Data interoperability of distributed EHR systems is critical for bettering medical decision-making, serving healthcare costs, and enhancing healthcare quality (Williams & Boren, 2018). EHR systems are essential information technology tools that improve healthcare delivery quality, increase patient safety, and reduce healthcare costs. In Tanzania, implementation of the EHR systems started in 2013, which include the Government of Tanzania-Hospital Management Information System (GoT-HoMIS), a data warehouse for health resources, e-LMS, integrated planning software, EMR for MNCH services, and an electronic referral system (Ehealth Strategy, 2013-2018).

Got-HoMIS has been developed by the Government of Tanzania and applied in 170 health facilities across the country, including major hospitals, since 2017 (Ehealth Strategy, 2013-2018). It has now been six years since GoT-HoMIS started to work in government hospitals. The EHR systems adopted in Tanzanian government hospitals must be interoperable with each other in order to share patient information and enable the delivery of safe and effective patient care.

To provide better health service delivery to citizens, electronic health records play a significant role in maintaining clinical history in government hospitals. In current practices, patients who get treatments from health centres or dispensaries are referred to the Iringa regional hospital with a referral letter from the health canter or dispensary to which they were admitted before. Then they must restart the admissions processes and pay all necessary fees. This is because some of the patient health records are not shared across different government hospitals. Interoperability of electronic health records (EHR) systems for Tanzanian government hospitals is one of the

prevailing challenges, that has been given high attention by the government (Tanzania-Digital-Health-Strategy, 2019-2024).

Despite the fact that GoT-HoMIS and AfyaCare, have been applied in different government hospitals, each node maintains its own electronic health records where a patient's data from one EHR system cannot be found in another EHR system, which causes difficulty in searching for patients' data histories (Tanzania-Digital-Health-Strategy, 2019-2024). This situation increases health risk, costs for patients, and ultimately risks the optimization of the EHR systems applied within Tanzanian government hospitals.

2. REVIEW OF LITERATURE

A number of local software developers and the availability of open-source software have led to improved development and management of various hospital management information systems (HoMIS) in developing countries (Karuli et al., 2014). In Tanzania, a number of hospitals (public and private) operate different information systems for the storage and manipulation of clinical and administrative information, which include the GoT-HoMIS, JEEVA, MEDIPRO, EHMS, AfyaCare, Care2x, and others. (President Office (PO-RALG), 2017).

The Tanzanian government's support and emphasis enable the development and operationalization of GoT-HoMIS and AfyaCare. One of the benefits of using GoT-HoMIS and AfyaCare is the generation of reports that assist in hospital administration as well as monitoring clinical operations (Nyasubi et al., 2014). The purpose of GoT-HoMIS, an electronic information system, is to gather and present clinical data at the facility level, thereby aiding health facilities in their service delivery

GoT-HoMIS has been integrated with other systems in the health sector, including the National Health Data Centre, insurance providers, the Medical Store Department (MSD), and GePG. The Government of Tanzania adopted GoT-HoMIS. Since 2017, 170 health facilities across the country, including major hospitals, have adopted GoT-HoMIS. Among the 170 health facilities covered by GoT-HoMIS are regional hospitals (20), district hospitals (65), health centres (57), and dispensaries (28) (President Office, 2017). It has now been six years since GoT-HoMIS started to work in government hospitals.

The strength of GoT-HoMIS lies in the fact that it is modular, scalable, developed by a local specialist, and managed by the President's Office-Regional Administration and Local Government (Kibaha Education Center(KBC), 2015). GoT-HoMIS shares data with other remote systems, such as the government electronic payment system Gateway (GePG), the National Health Insurance System Fund (NHIF) system for member verification and claims, and the electronic Laboratory Management Information System (e-LMIS) from the Medical Store Department (President Office (PO-RALG), 2017).

AfyaCare is a hospital management information system that improve revenue collection and clinical processes in regional and zonal hospitals. AfyaCare is customized from the Open MRS software, which is open-source software. OpenMRS is an electronic medical records system that has been built by a collaborative effort between teams at Registries Institute in Indianapolis and Partners in Health (PHI), an NGO in Boston, USA. It has been designed for use in the developing world and first established in 2004 (Tiemey et al., 2016). It is among the most popular open-source EMRs. More than 25 developing countries, including Tanzania, have successfully deployed it, including Tanzania (Tihomirovis & Grabis, 2016). EHR system interoperability enables timely access to patient information whenever and wherever needed. It also reduces the need to recapture the same information in every system and the accompanying data capture errors that could arise from entering the same information multiple times (European Commission, 2018).

It empowers healthcare professionals, since they are able to make informed decisions and provide personalised care to patients based on more accurate information (Kaushai et al., 2019). EHR system interoperability also enables better healthcare coordination to support continuity of care through the improved communication of referral notes, patient medical histories, laboratory test results, and other relevant documents (Halamka et al., 2015).When considering the benefits of GoT-HoMIS implementation and usage, the standard and interoperability of the country's EHR system are critical aspects. According to (Adebesina et al., 2013), the absence of standards and the interoperability of the system are the major barriers to the development of the GoT-HoMIS in the country.

The system interoperability of GoT-HoMIS is still challenging, as reported by the Ministry of Health, Community Development, Gender, Elderly, and Children (MOHCDGEC) (Kalegele & Kajirunga, 2015). The consequences of the lack of standard and interoperability of GoT-HoMIS and AfyaCare result in poor and inconsistent data from multiple sources (West et al., 2015); (Ehealth Strategy, 2013-2018). Difficulty keeping and updating patient records, and duplication of diagnosis and patient history together reduce the acceleration of adoption and use of GoT-HoMIS in the country.

According to (Akarch, 2019), interoperability challenges comprise the following: standardization of information, unique patient identifiers, high interoperability costs, privacy and security, missing data, use of an outdated legacy system, interface discrepancies, the existence of medical records, patient ID errors and human errors. Any country's e-health plans and initiatives should incorporate seven components of interoperability. The ITU (2015) classifies five of the components as enabling environments, while the remaining two are ICT environments. The interoperability drivers identified by the WHO and ITU encompass leadership and governance, strategy and investment, legislation, policy, and investment, as well as workforce, standards, infrastructure, services, and applications.

- **Leadership and governance**: Provide for the necessary decision-making rules and procedures that give directions to and oversee interoperability initiatives (Pardo & Burke, 2019).
- **Strategy and Implementation:** This component refers to the development of a national roadmap that guides the coordination of e-health initiatives. The national e-health system should be aligned with the country's health priority area. It should identify interoperability goals and provide a plan of action to achieve them.
- **Legislation, Policy, and Investment**: Privacy, security, and confidentiality of healthcare information should be considered and have to be addressed through the creation of an appropriate legal framework that can support the effective exchange of healthcare information. There should be policies and mechanisms that address e-health interoperability. (WHO & ITU, 2017).

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- **Workforce:** This component is required to ensure that the necessary health informatics knowledge and skills are available to implement e-health initiatives. Adequate training and education programmes should be developed in order to build a workforce that is capable (mHealth, 2016).

- **Standards:** The adoption of e-health standards to support interoperability should be coordinated at the national level through an independent governance structure (Stroetmann et al., 2017). Standardization is the most critical driver of interoperability (European Commission, 2018).

- **Service and application:** This component represents the tangible means for enabling necessary applications, tools, and services that will facilitate the secure exchange of health information (WHO & ITU, 2017).

Figure 1. E-health components.

The Government also developed a number of strategies and guidelines for the interoperability of the Electronic Health Records (HER) system. These include the National E-Health Strategy 2013-2018 and the Digital Health Strategy 2019-2024. The Guidelines and Standards for Integrated Health Facility Electronic Management System (iHFEMS) 2016, the e-Government Interoperability Framework and Standards (e-GIF) 2016, and the Government Enterprises Service BUS (GOV-ESB) 2021. Other efforts made by the government included the establishment of muungano gateway and health information mediator (HIM) in facilitating EHRS interoperability.

Therefore, dispite all of the efforts made by the government in ensuring the EHRS are interoperable, still -the two systems, which is Got-HOMIS and AfyaCare are not interoperable.

3. RESEARCH METHOD

A descriptive research design was applied in this study, which is both qualitative and quantitative, to provide insight into the setting of the problem (Gracewell, 2008). The research design suits the purpose because the aim of the research was to review the interoperability challenges and characteristics. The research was conducted at Kilolo district hospital, Iringa regional referral hospital, and TAMISEMI, where GoT-HoMIS and AfyaCare have been developed and used, respectively.

The study area was selected due to the location to be accessed easily and due to the experience in operating with GoT-HoMIS and AfyaCare. Questionnaires and interview were applied as data collection tools. The research applied a slovin's formula in determining the sample size whereby the sample size of 83 was found and used in this study for collection of data from three domains; include Iringa regional referral hospital, Kilolo District Hospital, and TAMISEMI as indicated in the table below

3.1.1.1 Table 1:Target population & sample frame

No	Area	Population	Frame
1	Kilolo District Hospital	27	26
2	Iringa Referral Hospital	45	42
3	TAMISEMI	16	15
	Total size	**89**	**83**

Source: Researcher, 2022

The descriptive statistics analysis was applied in analyzing the collected data by using Statistical Package for the Social Science (SPSS) whereby qualitative and quantitative analysis technique applied to get the findings.

4. RESULT AND DISCUSSION

This part presents an analysis and discussion of the study findings based on the objectives of the research. The aim of the study was to develop an electronic health records (EHR) system interoperability framework for the government hospital. In the analysis, the questions involved five sections, including systems administrators, health professionals, medical data clerks, patients, and hospital managers.

The research was formulated with four specific objectives, of the specific objective 3 was to develop an interoperability framework for electronic health record. Based on the number of challenges that made interoperability between EHRS difficult, five (5) EHRS interoperability components were analyzed to find out which ones suit for EHRS interoperability framework. The descriptive analysis statistic method was used to get the findings.

From the figure below, the study indicates that 51% of the respondents selected "All components" which reveals that the developed EHRS interoperability framework should involve all 5 components in order to cater for EHRS interoperability challenges.

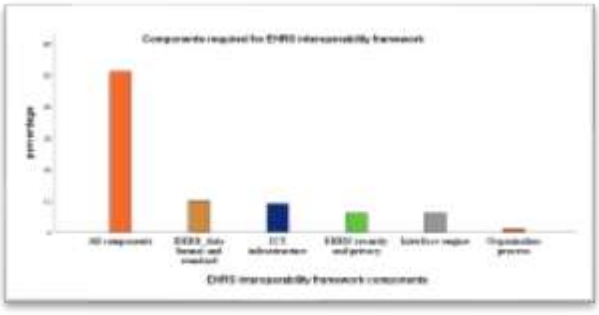

Figure 2.EHRS interoperability framework components

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4.1 Proposed Electronic Health Records (EHR) interoperability framework

The third objective of this study was to develop an electronic health record (EHR) system interoperability framework. Based on the analysis and findings of the study, five components namely, infrastructure, organization process, electronic health record (EHR) data format, interface engine, and information security and privacy, were used to develop the EHRS interoperability framework for the government hospital in Iringa. The framework was derived from the various literature reviewed during the study, problem statement, as well as the research gap. Figure 3 shows the proposed electronic health record systems (EHRS) interoperability framework for government hospitals.

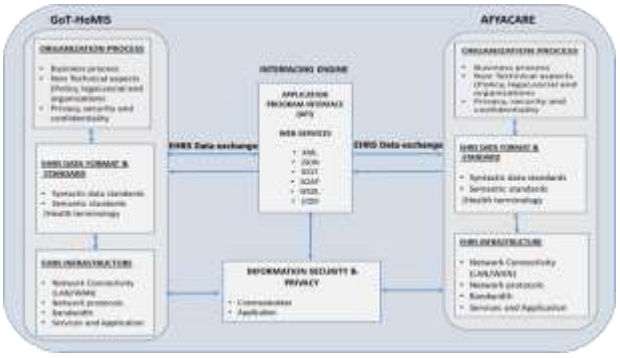

Figure 3: Electronic Health Records (EHR) System interoperability framework

Source: Field Data 2023

4.1.1 Organization Process

- Enable the secure, seamless, and timely communication and use of data both within and between organizational entities, and individuals
- An appropriate legal framework is required which can support the effective exchange of healthcare information (Pardo & Burke, 2019)
- An appropriate policy that addresses EHRS interoperability and mechanism is required to ensure compliance with interoperability policies (ITU, 2015)

4.1.2 EHRS data format and standard

- Data health standards enable EHRS and devices to exchange data successfully.
- Syntactic data format standards define the format, syntax, and organization of data exchange (HL7, FHIR and CDA) (ITU, 2015)
- Semantic data standards enable different EHRS to exchange data accurately with a common format and meaning (ICD ,SNOMED CT and LOINC) (WHO, 2016)
- GoT-HOMIS and AFYACARE uses ICD disease diagnosis purposes

4.1.3 EHRS Infrastructure

- Infrastructure comprises hardware/software components, systems, and platforms that enable machine-to-machine communication.
- It covers key issues such as data presentation, communication technologies, technical infrastructures, technical architecture styles, data exchange, security services, interconnection services, discovery services, information accessibility services, and metadata Information security and privacy.

4.1.4 Interface engine

- These are interfaces, which facilitate communication and data exchange between two or more different systems.
- APIs allow different applications to request information from each other and use each other's facilities.
- APIs can be implemented using middleware technologies, which are web-based technologies such as SOAP, REST-based services, or higher level programming languages (Kumari, 2015)
- SOAP and WSDL are XML–based protocols that support both the exchange of information and service communication (Kumari, 2015)

4.1.5 Information security and privacy

- Information security defines the level of authorization and authentication done for any updates performed on the data.
- To achieve full interoperability, it is crucial to clearly define who has access to the system (authentication) and who has access to specific areas of the system (authorization), as this ensures security and, when implemented well, enhances privacy.
- The patient's health records are sensitive and demand the highest level of privacy and security. Data security aims to ensure that EHRS data is not compromised.

5. CONCLUSION AND FURE WORK

The findings presented from this study, have shown that the interoperability of electronic health record (EHR) systems should take into consideration five issues, which include organization aspects, infrastructure, data format and standards for health care services, security, and interface engines.

The findings assist the researcher in developing an EHRS interoperability framework for government hospitals in Iringa. There are five main components, which include organisation aspect, infrastructure, data format and standards, security, and interface engine.

The interface engine is one of the components, that facilitates communication and data exchange between two or more different systems. It has been found that most of the respondents said that infrastructure and organization processes tend to become barriers to interoperability for GoT-HOMIS and AFYACARE. Both AFYACARE and GoT-HOMIS have been installed locally and are not yet centralised

In addition, it has been found that some of the respondents did not agree with the presence of GOV-ESB in solving the EHR interoperability issue due to the privacy and security of patient data and the requirements needed for joining GOV-ESB. This reveals that there should be a separate EHRS interoperability platform, which can only serve data sharing from different government hospitals, instead of mixing data with other government sector systems like NIDA, BRELA, and others.

A ranking of 91-100 % implies that the EHRS interoperability framework is highly acceptable and can be applied as guidance for successful EHRS interoperability. This indicates the capability of the EHRS interoperability framework solve EHRS interoperability issues.

In order for EHRS to join with Gov-ESB, one of it is that the systems should be centralized and hosted in one of the authorized data centers. AFYACARE and GoT-HoMIS have not yet centralized, and they have been locally hosted on the health premises; hence, they cannot join with Gov-ESB to accomplish interoperability, and for the moment, they will continue facing interoperability issues. This research focused on developing interoperability framework for EHRs, but further researches can be conducted to come up with EHRS-GATEWAY whereby not only government hospital health records will be shared but for all patient's data, including patient's data from the private hospitals which have registered in Tanzania.

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