# INTEROPERABILITY FRAMEWORK FOR ELECTRONIC HEALTH RECORDS (EHR) SYSTEMS FOR TANZANIA GOVERNMENT HOSPITALS IN IRINGA REGION

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN INFORMATION AND COMMUNICATION TECHNOLOGY MANAGEMENT**

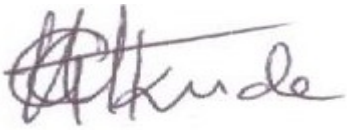
**DEPARTMENT OF MATHEMATICS, INFORMATION AND COMMUNICATION TECHNOLOGY**

**OF THE OPEN UNIVERSITY OF TANZANIA**

**2024**

## CERTIFICATION

The undersigned certifies that she has read and hereby recommends for acceptance by the Open University of Tanzania a proposal entitled **"Interoperability Framework for Electronic Health Records (EHR) Systems for Tanzania Government Hospital in the Iringa region".** In partial fulfilment of the requirements for the award of a Master of Science in Information Technology Management (MSITM).



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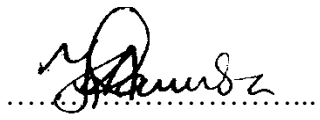
## COPYRIGHT

## DECLARATION

I, **Yahya Ally Kamba,** declare that, the work presented in this dissertation is original. It has never been presented to any other university or institution. Where other people's works have been used, references have been provided. It is in this regard that I declare this work as originally mine. It is presented here in partial fulfilment of the requirement for the Degree of Masters of Science in Information Technology Management (MSc-ITM)



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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. Many of the government health facilities have adopted different health information systems, like GoT-HoMIS, Afya Care, EHMS, and others, which have been deployed locally where each of them stores its own patient medical records and still has not centralised them. Therefore, the patient medical records between these health facilities cannot be exchanged and used among themselves. Interoperability will allow different information systems and organisations to work together. The study will address 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 frameworks developed 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. The results of the study reveals that the major barriers of EHRS interoperability are organization and ICT infrastructure. Therefore the study come up with an appropriate EHRS interoperability framework for the Government hospitals that can be used to design and implement interoperability of heterogeneous Eectronic Health Records (HER) Systems.

***Keywords:*** *Interoperability; EHRs; EHRs interoperability framework; GoT-HoMIS; AFYA CARE*

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| | |
|---|---|
| AIDS | Acquired Immune Deficiency Syndrome |
| BRELA | Business Registration and Licensing Agency |
| CDA | Clinical Document Architecture |
| CORBA | Common Object Request Broker Architecture |
| DBMS | Database Management System |
| DCOM | Distributed Component Object Model |
| DSI | Distributed Interactive Simulation |
| DSS | Decision Support System |
| EAI | Enterprise Application Integration |
| EHRS | Electronic Health Records System |
| EMR | Electronic Medical Records |
| FHIR | Fast Healthcare Interoperability Resources |
| GePG | Government electronic Payment Gateway |
| GoT-HoMIS | Government of Tanzania Hospital Management Information |
| GOV-ESB | Government Enterprise Service BUS |
| HIS | Hospital Information System |
| HIV | Human Immunity Virus |
| HL7 | Health Level Seven |
| HLA | High-Level Architecture |
| HOMIS | Hospital Management Information System |
| ICD | International Classification of Disease |
| JSON | Java Script Object Notation |
| KBC | Kibaha Education Center |

| | |
|---|---|
| LAN | Local Area Network |
| LOINC | Logical Observation Identifiers Names and Codes |
| Mpb | Megabyte per second |
| MSD | Medical Store Department |
| MTUHA | Mfumo wa Taarifa za Uendeshaji wa Huduma za Afya |
| NHIF | National Health Insurance Fund |
| NIDA | National Identification Authority |
| OW | Ontology web language |
| PO-RALG | President Office-Regional Administration and Local Government |
| REST | Representational State Transfer |
| RMI | Remote Method Invocation |
| SDMX-HD | Statistical Data and Metadata Exchange Health Domain |
| SNOMED-CT | Systemized Nomenclature of Medicine Clinical Terms |
| SOA | Service Oriented Architecture |
| SOAP | Simple Object Access Protocol |
| SPSS | Statistical Package for Social Science |
| SQL | Structured Query Language |
| UDDI | Universal Description, Discovery and Intergration |
| UPS | Un interruptible Power Supply |
| W3C | World Wide Web Consortium |
| WAN | Wide Area Network |
| WHO | World Health Organization |
| WSDL | Web Service Description Language |

| | |
|---|---|
| XML | Extensible Mark-up Language |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background to the Problem

Interoperability in the local healthcare systems has not been realized 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). Many countries have been actively engaged in the development of interoperability for data exchange and electronic transactions among government agencies to provide better 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 information and use the exchanged information (Geraci et al., 2017). Standardisation 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 tools of information technology that improve the quality of healthcare delivery, 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 need to be interoperable with each other in order to share patient information and enable the delivery of safe and effective patient care.

### 1.2 Problem Statement

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 centre or dispensary to which they were admitted before. Then they are required to restart the admissions process and pay all required costs. 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 optimisation of the EHR systems applied within Tanzanian government hospitals.

## 1.3 Research Objectives

### 1.3.1 General Objectives

The general objective of the research was to develop the interoperability framework for the Electronic Health Records (EHR) system for the Tanzanian government hospitals in the Iringa region.

### 1.3.2 Specific Objectives

The specific objective of the research were:

i. To identify the standard parameters that are adopted in existing health records in GoT-HoMIS and AfyaCare at Kilolo district hospital and Iringa referral hospital, respectively.
ii. To review interoperability challenges in health record sharing between GoT-HOMIS and Afyacare at Kilolo district hospital and Iringa referral hospital, respectively.

iii. To develop an Electronic Health Records (EHR) system interoperability framework.
iv. To evaluate Electronic Health Records (EHR) system interoperability framework.

### 1.4 Research Questions

The study will have the following questions:

i. What are the standard parameters adopted in existing health records in GoT-HoMIS and Afya Care at Kilolo district hospital and Iringa referral hospital, respectively?
ii. What are the interoperability challenges in health records sharing between GoT-HoMIS and AfyaCare at Kilolo district and Iringa referral hospital, respectively?
iii. How can the Electronic Health Records (EHR) system interoperability framework be developed?
iv. How can the Electronic Health Records (EHR) system interoperability framework be evaluated?

### 1.5 Significance of the Study

The study will add to the existing body of knowledge by future academic researchers, system developers, and other e-heath application stakeholders to be able to design an appropriate interoperability architectural framework for heterogeneous hospital information systems. The benefits of the proposed interoperability framework include a reduction in cost to patients with regards to ensuring that no test

has been repeated as the information is easily accessible, improved productivity among the doctors as the information is readily available, thus helping in faster decision-making, a reduction in waiting time, and also ensuring patient health record security. The study will also contribute to the availability of literature on the issue related to the interoperability of electronic health records (EHR) system frameworks, which will be used as study materials.

### 1.6 Scope of the Study

The study focuses on interoperability between GoT-HoMIS and AfyaCare installed at Kilolo district hospital and Iringa referral hospital, respectively.

### 1.7 Conceptual Framework

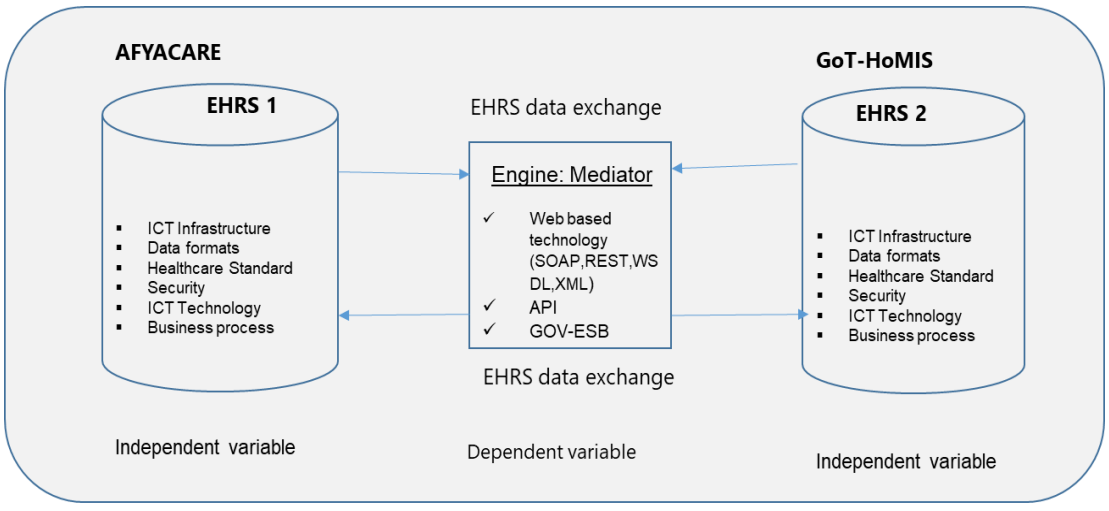


**Figure 1.1: A conceptual Framework for the EHRS Interoperability Framework for Government Hospitals**

The conceptual framework represents the two heterogeneous EHRS nodes (GoT-HoMIS and AfyaCare) as shwn in figure 1.1. The mentioned nodes are independent

variables, while the mediator is the dependent variable. Two EHRS nodes can exchange and use their data via the engine, which functions as a mediator.

The study applied these variables to find out EHRS interoperability challenges that hinders interoperability process between heterogeneous systems like Got-HOMIS and Afyacare, and to design an appropriate Electronic Health Record (HER) Syatem interoperability framework for the Government Hospitals in Iringa.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This chapter deals with the literature review related to the subject under this study of the interoperability framework for electronic health records (EHR) systems for the Tanzanian government hospitals. It presents an empirical review, a theoretical review, a theoretical framework, and a research gap.

## 2.2 Empirical Literature Review

This part presents empirical studies by other scholars on matters related to the interoperability of hospital management information systems. The study will look at all angles, from worldwide to Tanzania.

### 2.2.1 Electronic Health Records (EHR) System

The Electronic Health Records (EHR) system is used as a repository of patient data in digital form. EHRS can be accessed by multiple authorised users (Shankar et al., 2017). They provide quality patient care and safety and reduce costs while increasing the efficiency of work, permitting access to medical records from remote locations, and enhancing the speed and simplicity of record extraction. It is used for clinical care applications, clinical research functions, and administration functions (Shankar et al., 2017).

The most common EHRS is the Health/Hospital Management Information System (HoMIS), which includes the Government Health Registration System (Mfumo wa

Taarifa za Uendeshaji wa Huduma za Afya –MTUHA, the Swahili name for (GoT-HoMIS). The GoT-HoMIS integrates various core functional modules to serve the objectives of the Electronic Health Records (EHR) system, Laboratory Information System, Tracking and Inventory of Medical Supplies, Billing, and Revenue Collection (President Office, 2017).

As mentioned by the Strategic Plan (2013-2018), several national and referral hospitals have implemented some other EHRS, including open-source software such as Open MRS and Care2x, for many purposes like managing HIV/AIDS and registration (Kalegele & Kajirunga, 2015).

### 2.2.2 Hospital Management Information System (HoMIS)

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 system (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). Development and operationalization of GoT-HoMIS and AfyaCare are made possible due to the support and emphasis from the Tanzanian government. Among the advantages of using GoT-HoMIS and AfyaCare is the generation of reports that help in hospital administration as well as monitoring clinical operations (Nyasubi et al., 2014). GoT-HoMIS is an electronic

information system intended to collect and report facility-level clinical information and support health facilities in 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, as illustrated in Figure.2.1. The Government of Tanzania adopted GoT-HoMIS. It has been used in 170 health facilities across the country, including major hospitals, since 2017. 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).

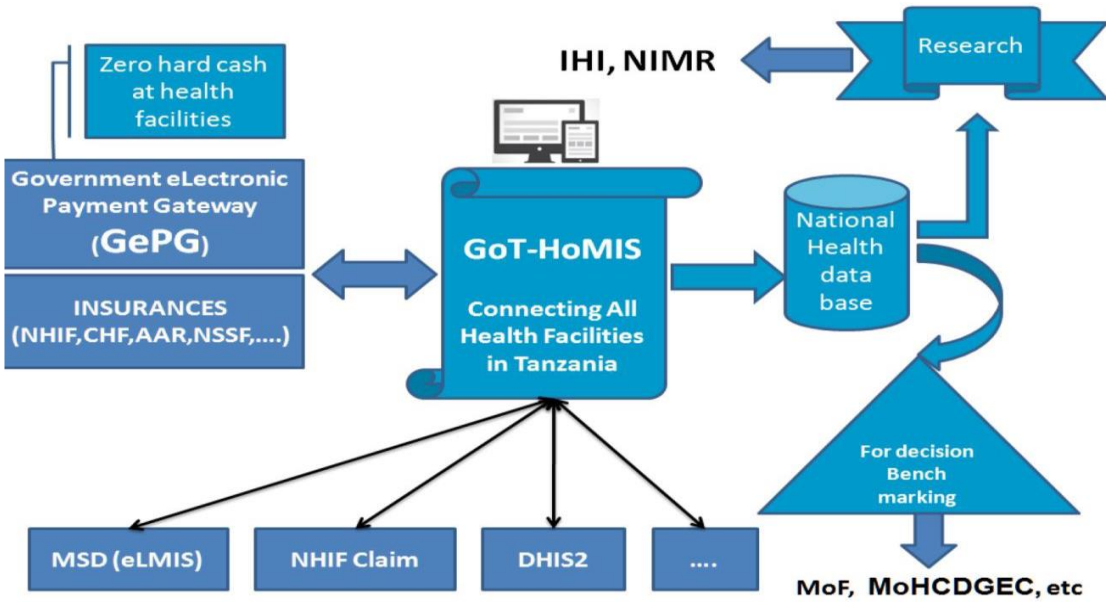


**Figure 2.1: GoT-HoMIS Connecting to GePG, MSD, NHIF, and DHIS2**

AfyaCare is a hospital management information system improving revenue collection and clinical processes in regional and zonal hospitals. AfyaCare is customised from the Open MRS software, which is an 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. It has successfully been deployed in more than 25 developing countries, including Tanzania (Tiemey et al., 2016).

### 2.2.3 Interoperability of Electronic Health Records (EHR) System

Interoperability is generally defined as the ability of two or more systems or components to exchange information and use the exchanged information (Wasala et

al., 2015). Interoperability of the Electronic Health Record (EHR) system can be defined as the system architecture that allows the electronic sharing of patient information between different EHR systems and healthcare providers, improving the ease with which doctors can provide care to their patients and patients can move in and out of different healthcare facilities (Pluard & Daniel, 2021).

### 2.2.5 Benefit of EHR Systems Interoperability

EHR systems 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 the entry of 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).

### 2.2.6 Challenges Facing Interoperability of EHR Systems (GoT-HoMIS and Afya Care)

When considering the benefits of implementation and usage of GoT-HoMIS, the standard and interoperability of the EHR system in the country are crucial 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.

### 2.3 Drivers of EHR Systems Interoperability

Seven components of interoperability have been identified that should be part of any country's e-health plans and initiatives. Five of the components are classified as enabling environments, and the remaining two are ICT environments (ITU, 2015). The WHO and ITU interoperability drivers include leadership and governance, strategy and investment, legislation, policy, and investment, workforce, standard, infrastructure, service, 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).
- **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 programs 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). Standardisation is the most critical driver of interoperability (European Commission, 2017).
- **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)

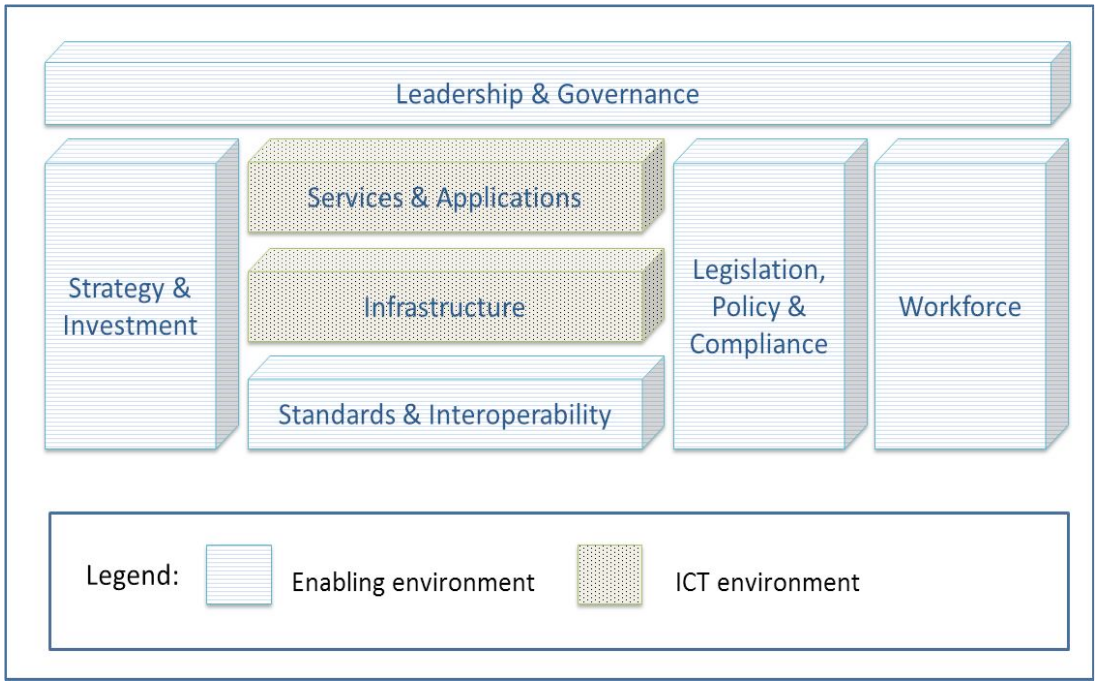


**Figure 2.2: E-health Components, by (WHO & ITU, 2017)**

### 2.4 Government Initiatives Toward EHR System Interoperability

The Government has developed strategies and guidelines for the interoperability of the Electronic Health Records (HER) system. These include the National E-Health Strategy 2013-2018, 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 (GOVESB) 2021.

#### 2.4.1 National E-Health Strategy 2013-2018

The Ministry of Health Community Development Gender Elderly and Children developed the National E-health Strategyin 2013.Among the strategic objectives of the National-E-Health Strategy is to enable an electronic communication and information-sharing mechanism for the referral system to improve the quality of

service and to establish e-Health standards, rules, and protocols for information exchange and protection.

### 2.4.2 Digital Health Strategy July 2019-June 2024

The Ministry of Health, Community Development, Gender, Elderly, and Children developed the strategy. Among the strategic objectives of the digital health strategy is to enhance seamless and secure information exchange. According to this strategic initiative, currently, the digital health landscape faces various challenges, including fragmented data systems, uncoordinated business processes, limited information exchange capabilities, inadequate data standards across the health sector, inadequate applications of information security standards, and ineffective data management and dissemination mechanisms. The strategy priority intends to strengthen ongoing efforts in developing system interoperability to enhance seamless and secure information exchange across the health sector.

### 2.4.3 Guideline and Standard for Integrated Health Facility Electronic Management Systems (IHFeMS) 2016

The e-Government Authority in collaboration with the Ministry of Health developed the iHFeMS guidelines and standards. The guidelines intend to address challenges faced by the existing health facility management system in the Tanzanian landscape, such as lack of standards, hampering data exchange, and information sharing. The vision of the iHFeMS initiatives was to have systems that could provide seamless integration between functions for smooth patient movement within various services.

### 2.4.4 E-Government Interoperability Framework Standard and Guideline (e-GIF)

E-GIF provides the government with the ability to share information and integrate information and business processes, by using the common standard. They make ICT systems and the processes they support interoperable based on well-accepted standards. This framework was developed by e-GA in 2016.The objective of e-GIF is to provide the know-how to achieve interoperability of data and information within and outside the government.

### 2.4.5 Establishment of Government Enterprise Service Bus (GOVESB)

Government Enterprise Service Bus provides a middleware infrastructure that is process driven, loosely coupled, and supports the integration of heterogeneous systems based on open standards to help in rapid development, assembly, and deployment of services, easy maintenance, and improved business visibility. GOVESB is important in order to achieve information exchange between service providers and consumers. The GOVESB was developed by e-GA in 2021.

### 2.4.6 Establishment of Health Information Mediator (HIM)

The Health Information Mediator (HIM) is a middleware application developed by the Ministry of Health to support data exchange from one system to another. The HIM features consider four major interoperability aspects. 1) Client-level data exchange for priority hospitals, 2) Aggregate data exchange for District Health Information System 2 (DHIS2). 3) Health facility data exchange. 4) Health facilities reporting, allowing the HIM to exchange and report data among 11 systems

including the Electronic Logistic Management Information System, Vaccine Information Management System, Epicor 9, Human Resource HIS, Healthy Facility Registry, Health Data Repository, DHIS2, MEDIPRO, Care2x, Jeeva, and e-Medical (Ministry of Health, 2019).

### 2.4.7 Establishment of Muungano Gateway

Muungano Gateway is the government electronic system that has been developed by PO-RALG in collaboration with the PS3 project to enable other systems to communicate with each other and exchange information with the objective of improving operational efficiencies. It simplifies communication between systems within PO-RALG, which include systems like PlanRep, Epicor, and FFARS. Through the Muungano Gateway, health information systems deployed in health centres can communicate and exchange information with others via a health information mediator (HIM) (PO-RALG, 2019).

## 2.5 Theoretical Literature Review

The theoretical framework consists of concepts, definitions, and references that are relevant to this study. The framework seeks to understand interoperability concepts and how they relate to the focus of the study (Alabama State University, 2017).

**Interoperability Definitions:**

1. Interoperability is the ability to exchange and use information, usually in a large heterogeneous network made up of several local area networks (Webster online , 2008).

2. Interoperability is the condition achieved among communication electronic systems or items of communication electronic equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. The degree of interoperability should be defined when referring to specific cases (Department of Defense, 2008).
3. The ability of two or more systems or components to exchange information and to use the information that has been exchanged (IEEE, 2015).
4. The capability to communicate, execute programmes or transfer data among various functional units in a manner that requires the users to have little or no knowledge of the unique characteristics of those units (ISO/IEC, 2003).

The above definitions emphasise three major points that happen in all of the working definitions of interoperability found in the literature.

- **Information exchange**: interoperable systems are characterised by their ability to exchange information. From the above definitions, it emphasises that interoperability is a condition that must be achieved, which implies that systems are interoperable when they are interoperable.
- **Usability of information**: The use of information is determined by the receiving systems, which implies that the receiving systems are not only able to process information but also determine which information it can use and which it should throw out. The usability of information also adheres to the direction of information flow, which is important to identify during interoperability.

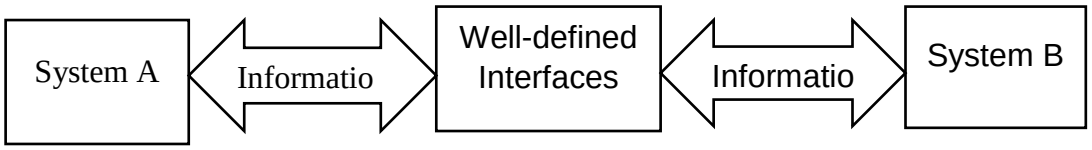


**Figure 2.3: A Conceptual view of interoperability, by (IEEE, 2008)**

- **Interoperability exists in levels:**

Two sets of the definition above are discussed to provide an informative view of interoperability. The ISOC/IEC definition focused on the exchange of bits and bytes, while the other definitions address the exchange of information between systems. The fact that interoperability exists in levels has been noted in the body of knowledge (Clack et al., 2011). There are four levels of interoperability, which consist of technical, syntactic, semantic, and organization.

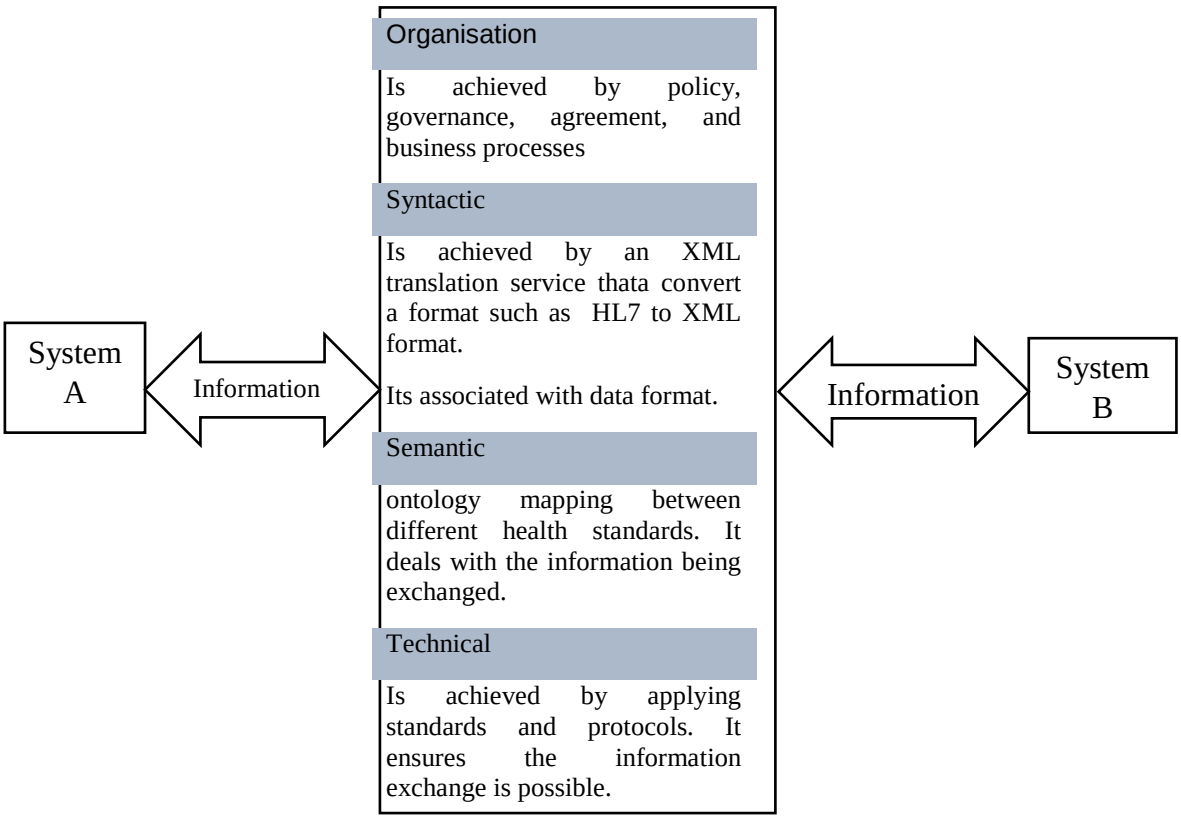


**Figure 2.4: Interoperability Exists in Levels, by (Clack et al., 2011)**

Figure 2.4 indicates how interoperability occurs at different levels, where each system that needs to be interoperable with other systems should adhere to these levels. Interoperability levels comprise components, which act as drivers of system interoperability**.**

- **The Objective of Interoperability**: The main goal of interoperability is to exchange useful information between heterogeneous systems. To achieve this goal, it is essential to provide a way to exchange information and come to a common understanding of the information being exchanged.

### 2.6 Levels of Interoperability

Currently, there is no consensus on the level of interoperability. Some authors define three levels, while others define eight and four levels of interoperability. According to (Whitman & Panneto, 2018; European Commission, 2018), four levels of interoperability have been defined: technical, syntactic, semantic, and organisational.

#### 2.6.1 Technical Interoperability

This enables the heterogeneous system to exchange data, but it does not guarantee that the receiving system will be able to use the exchanged data in a meaningful way (European Telecommunication Standard Institute, 2017).

#### 2.6.2 Syntactic Interoperability

This defines the structure or format of the medical information. It guarantees the preservation of the clinical purpose of the data during transmission in the healthcare

system. Syntactic allows making the translation between formats depending on which one is used between the different systems involved.

### 2.6.3 Semantic Interoperability

Semantic interoperability enables multiple systems to interpret the information that has been exchanged in a similar way through predefined shared meanings of concepts. The semantic level is achieved when two or more systems can exchange, interpret, and make use of information (European Commission, 2018). Achieving interoperability at the semantic level is more difficult in healthcare when compared with others, like the banking sector. This is because of the ambiguity that may arise from the use of medical terms (Pack & Hardiker, 2019).

### 2.6.4 Organisation Interoperability

This level of interoperability facilitates the integration of business processes and workflows beyond the boundaries of a single organization. It requires a strong willingness and commitment from the concerned organisation to collaborate (European Commission, 2018). To achieve this level of interoperability, policy, legal, social and organisational aspects must be taken into account.

## 2.7 Interoperability Paradigms

There are two main interoperability paradigms, which are Enterprise Application Integration (EAI) and Sevice Oriented Architecture (SOA).

### 2.7.1 Enterprise Application Integration (EAI)

Is defined as a collection of methods, tools, and services that work together to bring

heterogeneous applications into communication as part of the traditional, distributed, or extended enterprise (Manouvries & Menard, 2018). High interoperability is possible if the system is able to easily connect to reach organisational goals. (Josuttis, 2017). The demand for high interoperability gave rise to enterprise application integration (EAI) (Manouvries & Menard, 2018).

### 2.7.2 Service-Oriented Architecture (SOA)

Service Oriented Architecture (SOA) can be defined as a software architecture where functionality is modelled around business and provided as a reusable service. SOA also describes IT infrastructure that allows applications to exchange services and data in an interacting business process. One of the goals of the SOA is to create a loose coupling between service and technology. SOA architecture has main parts that combine and can provide usefulness (Rosen et al., 2018). The main parts of SOA include processes,services, integration, existing systems, documents, semantics, transformation, and communications. While EAI provides the transfer of information between systems. SOA provides shared functionality through services (Josuttis, 2017).

## 2.8 Different Architectural Approaches

There are different architectural approaches for achieving interoperability between systems (Lopes, 2019). The three main approaches are point to point, hub and spoke, and enterprise service bus(ESB).

### 2.8.1 Point to Point

Point to point interoperability approaches link two or more systems with an interface and are suitable when there are few systems in an interoperability solution (Lopes, 2019). However, if there are many systems that need to interoperate, the complexity increase (Braa & Sahay, 2016). In this approach, each interface translate the source format to the target format. This approach leads to tighty coupled applications, resists to system changes, and is not a scallability approach (Liu & Ozsu, 2019).

### 2.8.2 Hub and Spoke

The Hub and Spoke approach consists of a central hub that deals with mediation, transformation, routing, and spokes that connect the system to the hub (Goel, 2016). Compared to the point-to-point approaches, it only needs an X interface for X systems with a CDM. The hub provides translation from a system format to a format that other systems can understand. The centralised hub coordinates all the communications between senders and receivers (Josuttis, 2017).

### 2.8.3 Enterprise Service Bus

Enterprise Service Bus is an architectural patterns for a distributed infrastructure (Rosen et al., 2018). The architectural pattern offered by distributed infrastructure services are service location, routing directory, transactional support, transformation, mediation, specialised engine, monitoring, and service security support (Rosen et al., 2018). There are many ESB products, including Mule, Apache Service mix, Microsoft BizTalk Server, Progress Sonic ESB, and many more. An ESB is an important part of SOA and provides loosely coupled connectivity between servics

requests and service providers in service-oriented solutions (Liu & Ozsu, 2019). It has a central part, which is the message bus known as message-oriented middleware (MOM), which includes message communication channels.

## 2.7 Research Gaps

The study reviewed that the Government of Tanzania, through the Ministry of Health, has made many efforts in the development of e-health applications, including GoT-HoMIS, and AfyaCare, which are currently applied in some of the regional and district government health facilities. These systems are not centralised, even at the minimum level for those on the same platform. The collected data are therefore only limited to the health facility in which they operate (President Office (PO-RALG), 2017).

Therefore, it is not very beneficial when it comes to the search for patient records. The data from the GoT-HoMIS needs to be shared with AfyaCare and other health information systems deployed where integrated reports can be generated from the comprehensive dataset, enhancing tracking and control of the patient's disease. Therefore, despite the fact that the Government of Tanzania through the Ministry of Health has established many e-health strategic initiatives for improving health services through GoT-HoMIS and AfyaCare, there are still interoperability challenges. Therefore, this study aimed to understand interoperability challenges at all four levels as well as develop an appropriate electronic health records (EHR) systems interoperability framework to address the challenges.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter describes the methods and techniques used in the collection and analysis of data. These include the research design, population groups, sample and sampling procedures, research instrument, data collection procedure, and data analysis procedures.

## 3.2 Research Design

Research design is a detailed plan that indicates all steps on how the scientific questions about the research problem will be conducted (Silverman, 2001). A descriptive research design will be used in this study, which is of both qualitative and quantitative to provide insight into the setting of the problem (Grasswell, 2009). This research design will suit the purpose because the aim of the research is to review the interoperability challenges and characteristics. The framework will be selected due to the nature of the research questions (Grasswell, 2009).

## 3.3 Area of the Study

The study for this research was conducted at Kilolo district hospital, Iringa referral hospital, and TAMISEMI, where GoT-HoMIS and AfyaCare have been used, respectively. The study area was selected because the location can be accessed easily and due to the experience in operating with GoT-HoMIS and AfyaCare.

## 3.4 Population of the Study

The population of the study-involved staff from both Kilolo district hospital, Iringa

referral hospital, patients from Iringa referral hospital, and TAMISEMI. The group of ICT officers, EHRS data clerks, patients, and the management team will be involved in the study. This group has been chosen because of the experience that they have, the time to conduct the research, access to data, and the cost associated.

### 3.5 Sampling and Sample Type

Sampling is the process of selecting a subset of individuals within a population to estimate the characteristics of the whole population. The study applied random sampling since it allows all the units in the population to have an equal chance of being selected.

### 3.6 Sample Size

According to (Kothari, 2004), sample size refers to the number of items to be selected from the universe to constitute a sample. In this study, the sample included the number of individuals (ICT professionals from both hospitals and PO-RALG, medical data clerks, and professional doctors) who will participate in the study.

**Table 3.1: Estimated Target Population & Sample Frame**

| Area | Population | Frame | Sampling Design | Data Collection tool |
|---|---|---|---|---|
| Kilolo District Hospital | 27 | 26 | Random Sampling | Questionnaire& Interview |
| Iringa Referral Hospital | 45 | 42 | Random Sampling | Questionnaire& Interview |
| TAMISEMI | 16 | 15 | Random Sampling | Questionnaire & Interview |
| **Total size** | **89** | **83** | | |

**Note, Sourced from** (Researcher, 2022)

Sample size calculation for Kilolo district hospital and Iringa referral hospitals.By using slovin's formula provide the sample size (n) using the known population size (N) and acceptable error value (e) (Stephanie, 2020).$n = N \div (1 + Ne^2)$ whereby n= required sample size, N = the number of target population and e= margin of error or confidence interval.

### 3.7 Methods for Data Collection

The data sources include primary and secondary, where a number of data collection methods can be applied. There are several methods of collecting primary data, particularly in survey and descriptive research, which include the observation method, interview method, questionnaire, schedule, and other methods (Kothari, 2004). The study will apply questionnaire and interview methods of data collection.

#### 3.7.1 Interview

According to (Kothari, 2004) the interview method of collecting data involves the presentation of oral-verbal and written responses in terms of oral-verbal responses. This method can be used through personal or telephone interviews. The purpose of conducting an interview is to enable clarification of questions and to probe other questions to gain insight that cannot be found in the questionnaire. The interview will involve ICT officers from PO-RALG, Kilolo district hospital, and Iringa referral hospital.

#### 3.7.2 Questionnaire

The questionnaire is a method of data collection which is quite popular, particularly in the case of large inquiries. This method is adopted by private individuals, research

workers, private and public organisations, and even governments. A questionnaire consists of a number of questions printed or typed in a definite order on a form or set of forms. In this study, the questionnaire will be used to collect data at Kilolo district hospital and Iringa referral hospitals because it saves time and money.

### 3.8 Data Analysis

According to (Kothari, 2004) the term analysis refers to the computation of certain measures along with searching for patterns of relationships that exist among data groups. In this study, quantitative and qualitative data analysis techniques where applied, whereby the descriptive statistics analysis technique was applied as a quantitative data analysis technique to analyse questionnaire data. For the interview, thematic content analysis was applied as a quantitative data analysis technique. The SPSS v21 tool was applied to analyse quantitative and qualitative data types.

### 3.9 Measurement of Reliability, and Validity

Reliability can be defined as the consistency with which repeated measures produce the same results across time and across observers (Patton M., 2002). For this study, reliability was measured through the test-retest method using a questionnaire tool distributed to health workers. Validity refers to the extent to which the concept one wishes to measure is actually being measured by a particular scale or index, which is the extent to which an account accurately represents the social phenomena to which it refers (Babbies, 1992). To ensure the validity of the measures, the questionnaire was pilot-tested on some of the participants, and their comments were used to modify question

### 3.10. Ethical Issues in Research

This study ensured that access to the required data, its privacy and confidentiality, and its protection and storage were limited to the research. A request letter was sent to the various institutions in order to get permission to conduct data collection exercises, including interviews and questionnaires, and data will be limited only to authorised persons.

# CHAPTER FOUR

# FINDING AND DISCUSSION

## 4.1 Introduction

This chapter 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) systems 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. This chapter has been guided by the research objectives explained in the previous chapter. The data that have been collected were interpreted based on the research objectives and questions.

## 4.2 Demographic Profile of the Respondents

This section explores the background behaviour of the respondents and the differences in their profiles, which aims to show the respondent's data in terms of age. Gender, level of education, and working experience. 84 workers came from different workers within three entities, which are Iringa Regional Referral Hospital (IRRH), Kilolo District Hospital, and TAMISEMI. The response rate was 100%.

### 4.2.1 The Age of the Respondents

The age of the respondents is grouped into four (4) age groups. 48.19% of them were between 31 and 35 years old, 30.12% between 20 and 30 years old, 15.66% between 36 and 45 years old, and 6.02% between 46 and 59 years old. Figure 4.1 illustrates the age of the respondents

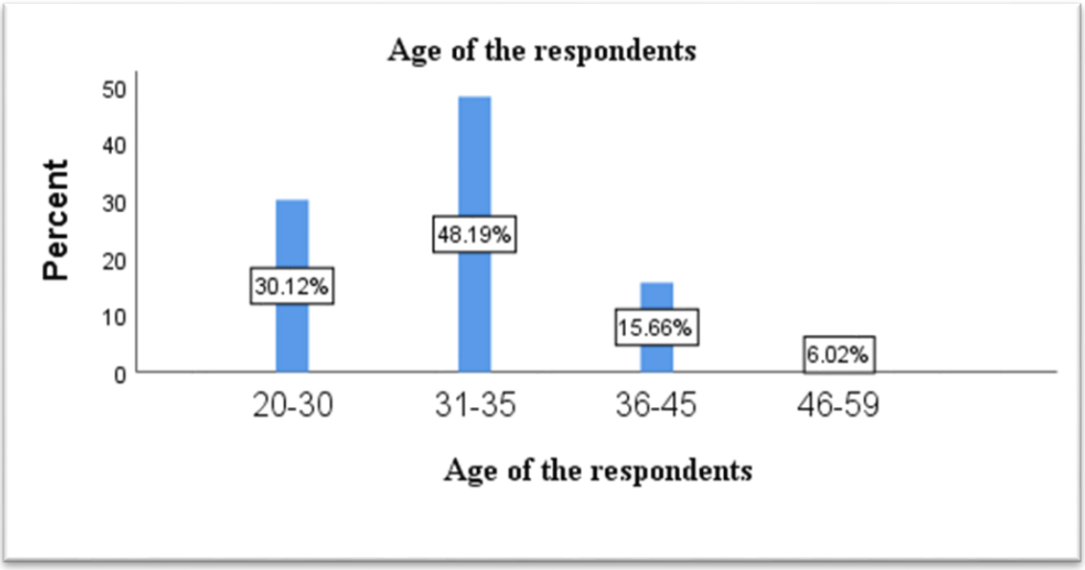


**Figure 4.1: Age of the Respondents by (Field *Data, 2023)***

### 4.2.2 Gender of the Respondents

Finding in Figure 4.2 shows that 62.65% of the total respondents were males and 37.35 % were female. This gender status implies that the information collected was, to some extent, equally represented by both genders. This represents the balance of both females and males in collecting data to get insights on the interoperability of EHRS between men and women.

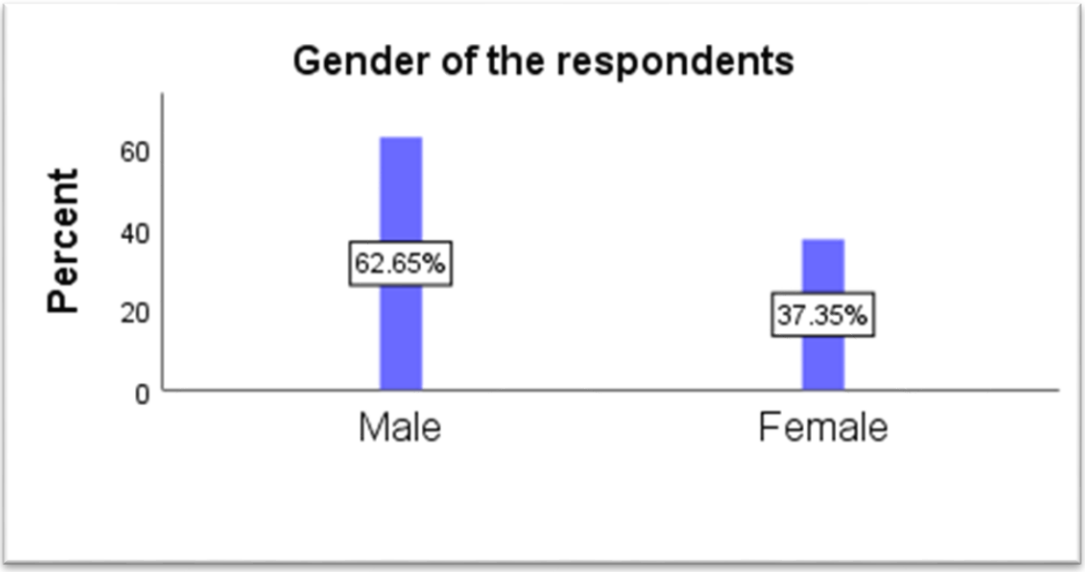


**Figure 4.2: Gender of the Respondents by (Field Data, 2023)**

**Source:** Field Data 2023

### 4.2.3 Education Level of the Respondents

The education level of the respondents was satisfied. The majority of the respondents had been in tertiary education and undergraduates, whereby 50% having diplomas, 2.5% having masters, 2.56% having postgraduate diplomas, 3.85% having advance diplomas, and 3.85% having a certificate level. Hence, the data on the level of education were collected because not all employees had the same educational qualification, which brings a variation. Figure 4.3 shows education level of the respondents

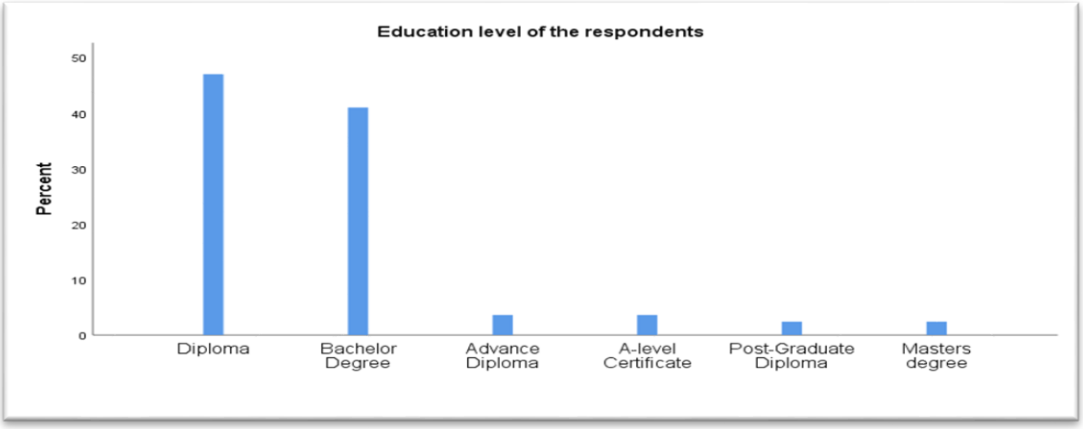


**Figure 4.3: Education Level of the Respondents, by (Field Data, 2023)**

## 4.3 Standard Parameters Adopted in Existing GoT-HOMIS and AFRACARE

### 4.3.1 Identification of the Standard Parameters Adopted in Existing Health Records in GOT-HOMIS and AFYACARE

In this analysis, a list of standard parameters adopted in existing health records in both GOT-HOMIS and AFYACARE, which are used for patient registration, were listed in the questionnaire. The standard parameters for EHRS identified include Medical_Rec_no, Health Insurance No, Full Name, Date of Birth, Gender, Tribe, Age, Residence, Occupation, Tribe, Religion, Marital Status, Address, Next of kin, Phone No, Relationship, as shown in Figure 4.4 of the patient registration page of the GOT-HOMIS.

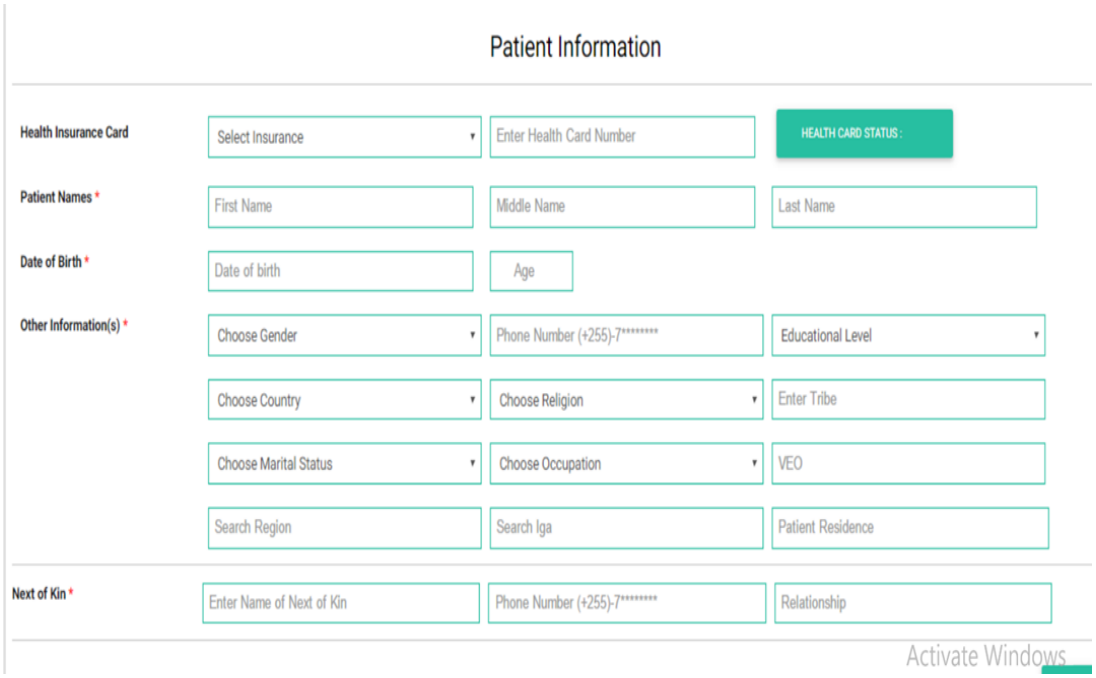


**Figure 4.4 GoT-HoMIS patient Registration Form, by (Field Data, 2023)**

The next of kin parameter goes with the relationship parameter, which identifies the closest family member (brother, sister, uncle, etc.) who can be contacted in case of anything. The marital status parameter is used here since some of the diagnostic processes require information about the marital status of the patients. The respondents (with the exception of patients) were asked about the existence of such parameters in GOT-HoMIS and AFYACARE. The finding in Figure 4.4 indicates that 69.88% of the respondents (with the exception of patients) agreed that the parameter provided in GOT-HoMIS and AFYACARE are the ones used for registering patients, and 30.12% of the respondents (with the exception of patients) strongly agreed in the same manner. This reveals that both EHR systems have almost the same health record parameters, which are used to register patients shared data and exchange data when the systems are interoperable.

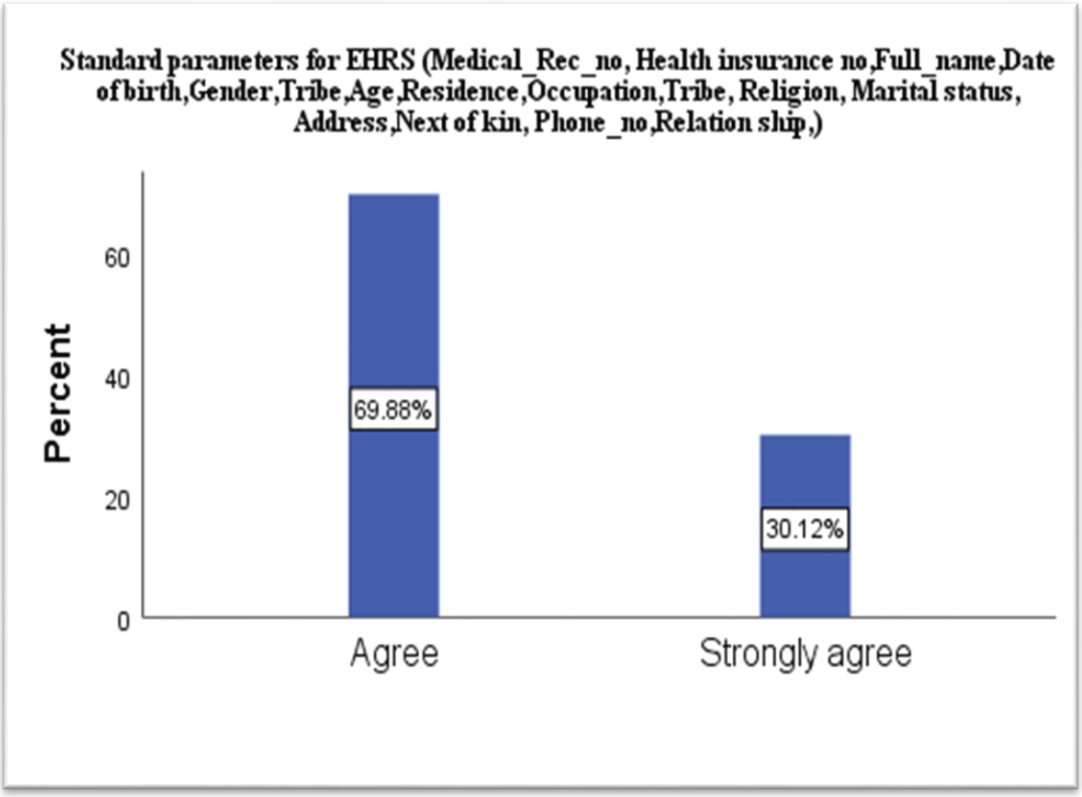


**Figure 4.5: Existing Health Record Parameters Found in GoT-HoMIS and AFYACARE, by (Field Data, 2023)**

### 4.3.2 Level of experience in using EHRS

In analysing the level of experience in working with GoT-HoMIS and AFYACARE, 55.4% of the respondents (with the exception of patients) have experience of 1 to 3 years, 33.7% of the respondents have experience of 4-6 years and 10.8% of the respondents have experience of 7 to 10 years, as indicated in Table 4.1

This indicates that users have been using EHRS for some time. In Iringa Reginal Referral Hospital, they were using GoT-HoMIS, and then after they had moved to AFYACARE.

**Table 4.1: Level of Experience in Using EHRS**

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| 1-3 years | 46 | 55.4 | 55.4 | 55.4 |
| 4-6 years | 28 | 33.7 | 33.7 | 89.2 |
| 7-10 years | 9 | 10.8 | 10.8 | 100.0 |
| Total | 83 | 100.0 | 100.0 | |

**Note, Sourced from** (Field data, 2023)

### 4.3.3 Type of Health Information Accessed in GoT-HoMIS and AFYACARE

Figure 4.6, indicates the information accessed from the EHRS such as GoT-HoMIS and AFYACARE, which were categorised into six groups. The accessed information in EHRS includes patient details, patients' diagnostic information, patient prescription information, and patient financial information. The analysis shows that 41.25% of the respondents (with the exception of patients) opt for patient details and financial information, and 8.75% opt for patient details, patients' diagnostic information, and financial information. The analysis also indicates that 5% of the respondents (with the exception of patients) opt for patient details, patient prescription information, and patient financial information, 1.2% of the respondents opt for patient details and patient diagnostic details, 3.7% of the respondents (with the exception of patients) opt for patient details, 40% of the respondents opt for all patient information. Therefore, the analysis interprets that these are all kinds of information that can be accessed to treat patients. During the interview, some of the respondents asked about the importance of information that can be accessed from EHRS like GoT-HOMIS and AFYACARE they gave the following feedback, which are:

- Efficient in making feedback
- Easy of recording and retrieval and
- Allow for quick reference

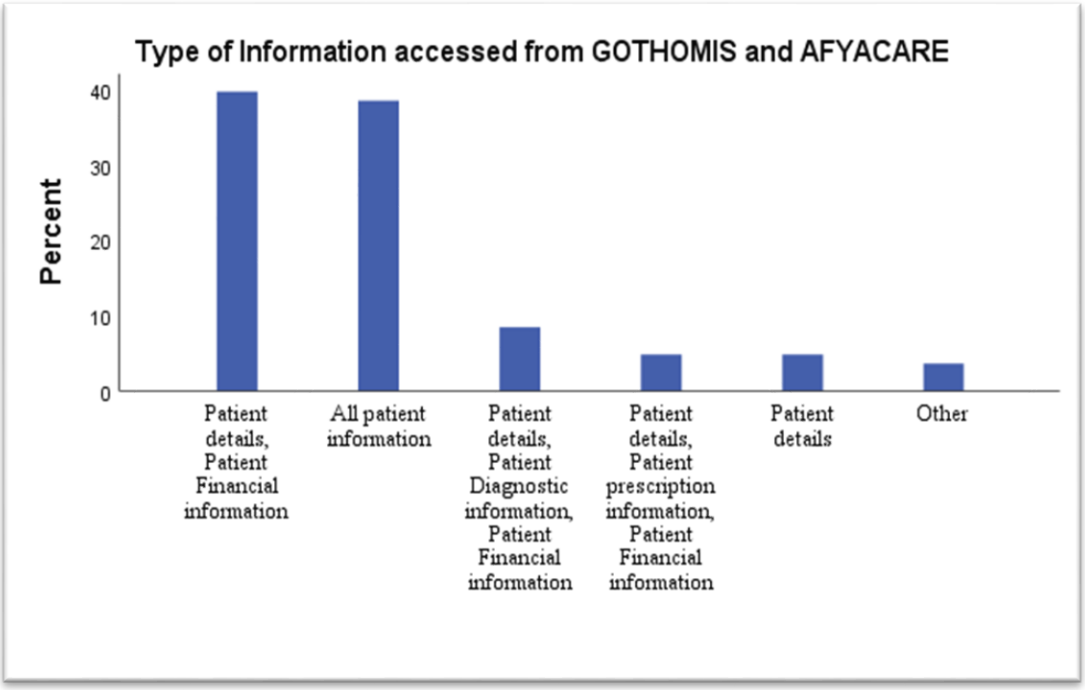


**Figure 4.6: Information Accessed in EHRS (GoT-HoMIS & AFYACARE), by (Field Data 2023)**

## 4.4 The Interoperability Challenges in Health Records Sharing between EHRS (GoT-HoMIS and AfyaCare)

### 4.4.1 Challenges Experienced when Attending to Referral Patients

The lack of the EHRS interoperability between GoT-HoMIS and AFYACARE is among the major challenges when attending to referral patients. Patient records from GoT-HoMIS and AFYACARE have not been shared with each other. For example, a practitioner may have difficulty obtaining complete information about a patient who

is currently being admitted. A practitioner may also repeat test because he or she does not have prior information about the patient. Therefore, in analysing these challenges, respondents (with the exception of patients) asked to provide opinions based on the challenges associated with patient referral.

Among the challenges experienced when attending to referral patients is the lack of patient records from the referring institutions, which slows down the process and repetition of the diagnosis process, increase the cost for re-diagnosis process, and delays in delivering health services. Figure 4.7 indicates that 60% of the respondents (with the exception of patient) were agreed on the mentioned challenges experienced, 37.30 % of the respondents strongly agreed on the mentioned challenges, and 2.4 % of the respondents did not agree on the mentioned challenges. Hence, 60.2% of the total respondents (with the exception of patients) were agreed on the challenges experienced when referring patients from one hospital to another because the EHRS applied is not interoperable. In section 4.4.3, the analysis reveals other EHRS interoperability challenges, which includes technical, organisation, data standard, and security challenges.

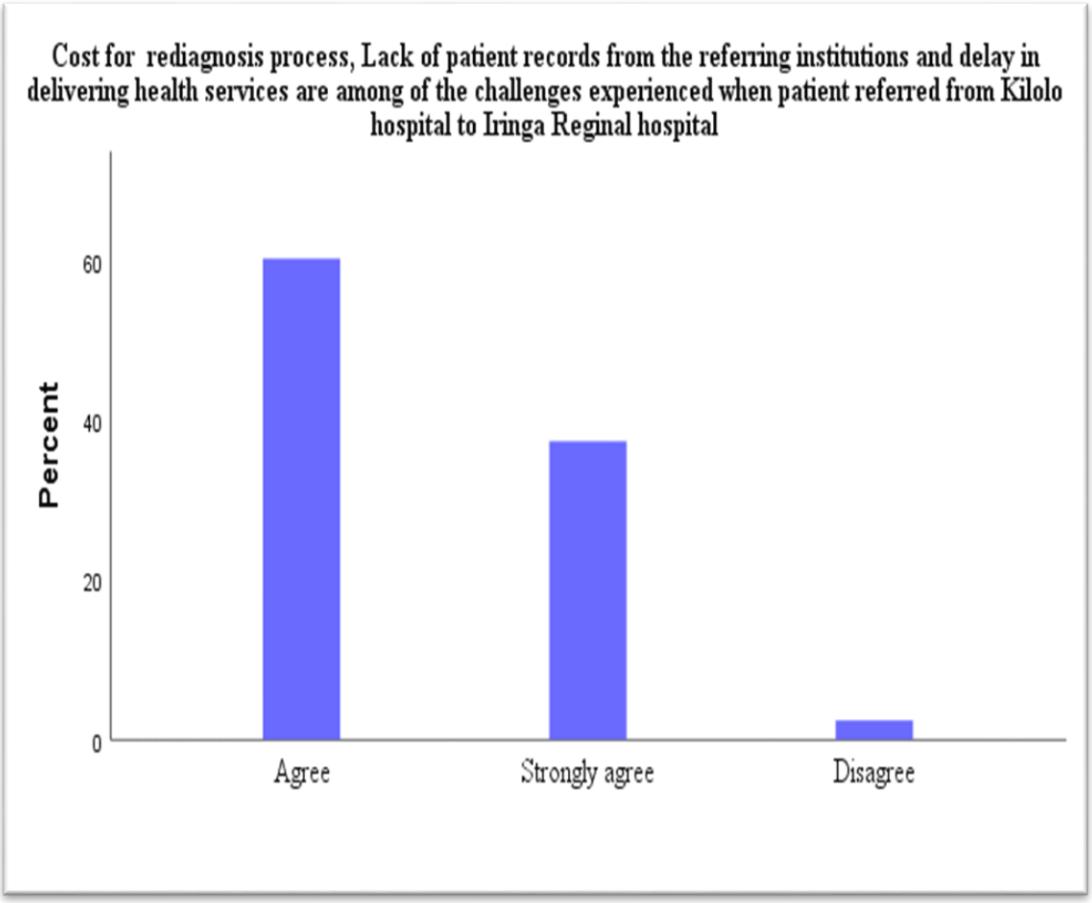


**Figure 4.7: Challenges Experienced when Patients were Referred from Kilolo Hospital to Iringa Referral Hospital by (Field Data 2023)**

### 4.4.2 The Presence of Mediation Systems Used for Sharing and data Exchange between EHRS

The study has revealed that there is no mediation system used for data exchange between GoT-HOMIS and AFYACARE. The finding presented in Figure 4.8 about the presence of the EHRS mediation system shows that 85.54% of the respondents (with the exception of patients) said “No”’, 8.43% of the respondents said “I dont’t know” and 6.02% of the respondents said “Yes. “

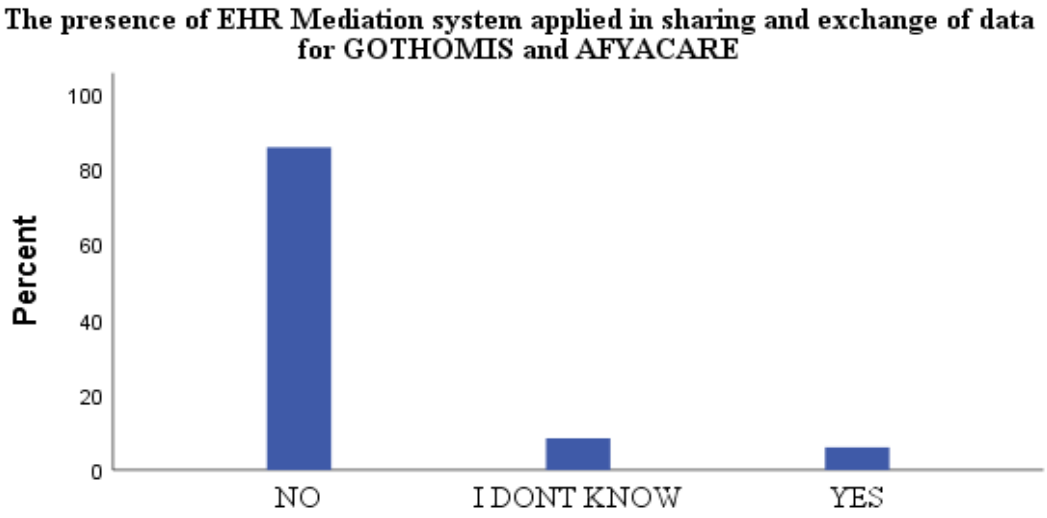


**Figure 4.8: The presence of a Mediation System for EHRS, by (**Field Data 2023)

### 4.4.3 Challenges for Making EHRS Interoperability

Interoperability of EHRS faced with various challenges including technical issues, data format and standard, organisation and data security and privacy. The intention of this question was to find out the key EHRS interoperability challenges**.**

Findings in Figure 4.9 indicates that 38.55 % of the respondents (with the exception of patients) opt for technical issues, 21.69% of the respondents (with the exception of patients) opt for "organisation policies and agreements", and 16.87% of the respondents (with the exception of patients ,IT system administrators, and TAMISEMI) opt for "I don't know". In addition, figure 4.9 indicates that 9.64% of the respondents opt for "both of them", 8.43% of the respondents opt to "EHR health standards" and 4.82% of the respondents opt for "technology applied in developing EHR systems". Hence, the findings reveal that the great challenge is in the infrastructure and organisation policies and agreements.

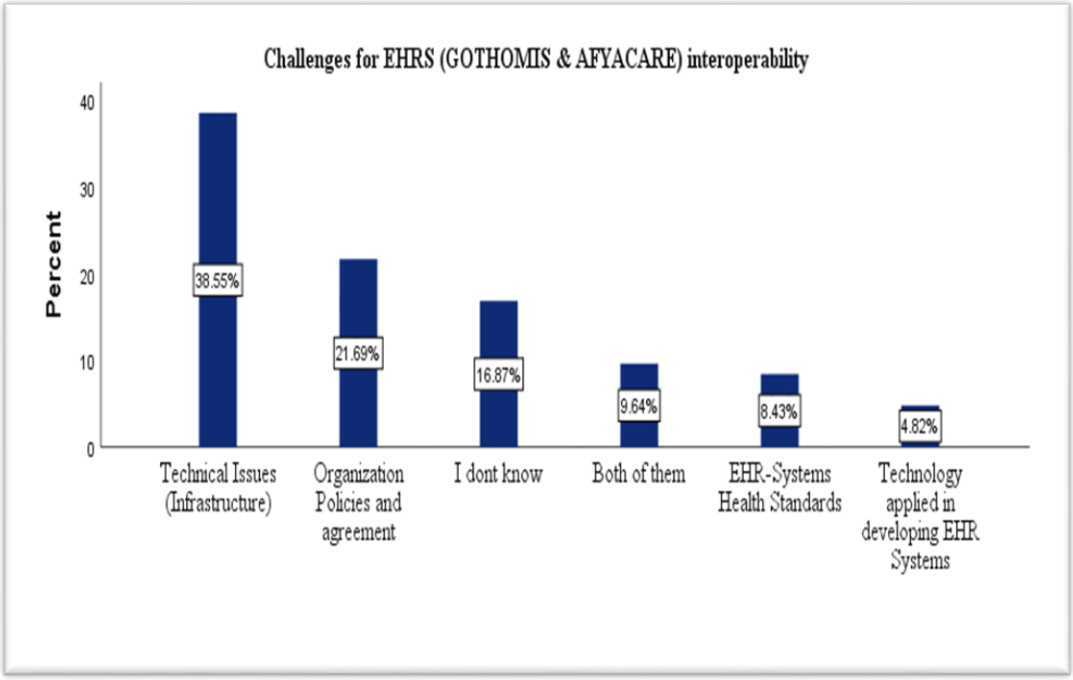


**Figure 4.9: EHRS Interoperability Challenges by (Field Data 2023)**

## 4.5 Electronic Health Record (EHR) System Interoperability

### 4.5.1 EHRS Interoperability Levels

In order to successfully achieve the interoperability of GoT-HOMIS and AFYACARE, four (4) levels of interoperability should be adhered to which involve organisation, syntactic, semantic, and technical. Figure 4.10 indicates that 32.53% of the respondents (IT system administrators and TAMISEMI), agreed the levels of interoperability. 4.82% of the respondents (IT system administrators and TAMISEMI) strongly agree with the levels of interoperability. 59 % of the respondents (with the exception of TAMISEMI and IT System administrator), they do not know about the levels of interoperability mentioned and 3.6% of the respondents disagree the levels of interoperability mentioned. The analysis reveals

that ICT and some medical staff have knowledge on the levels of interoperability, while the rest of the respondents had no knowledge regarding interoperability levels.

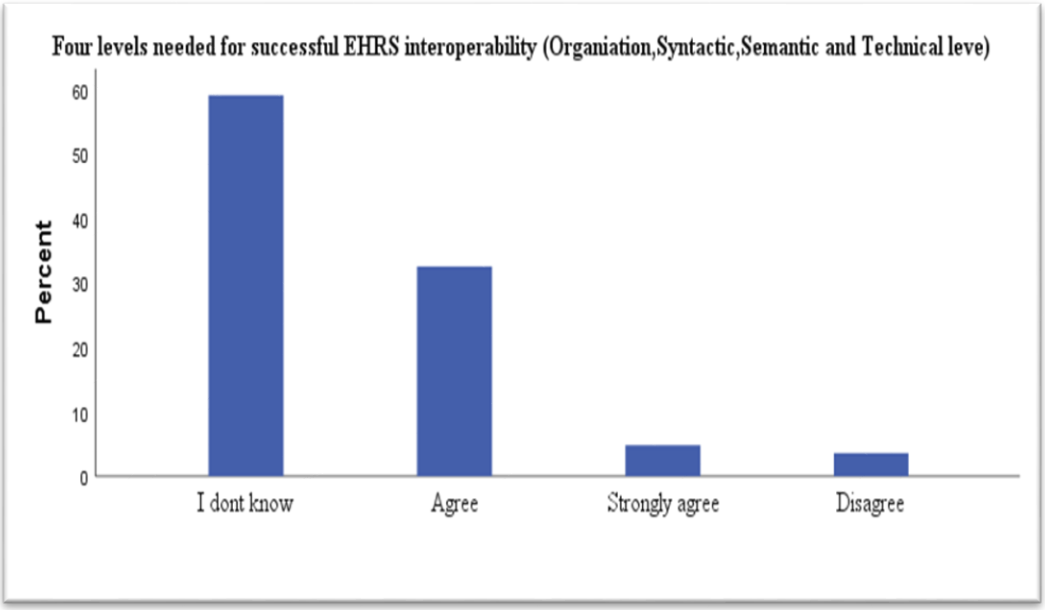


**Figure 4.10: Interoperability Levels for EHRS Interoperability, by (Field Data 2023)**

### 4.5.2 Other Concerns for EHRS Interoperability

In successfully achieving EHRS interoperability, some aspects need to be considered. These aspects can be alternatively termed ERHS interoperability likelihoods. The analysis intended to know if GoT-HOMIS and AFYACARE suit interoperability by looking at some aspects needed to make it happen. Therefore, a few interoperability aspects were among the information listed on the questionnaire, including the centralisation of the system, new technology involvement, and consideration of EHRS interoperability levels. Respondents (with the exception of patients) were asked to provide their understanding based on the facts provided.

Respondents have different opinions, as indicated in the Figure 4.11 where 63.86% of the respondents (with exception of patients, TAMISEMI and system administrators) they do not know anything about it. 14.46% of the respondents (with the exception of patients) opt for “the EHRS system should be centralised”, 1.2% of-the respondents opt for “system should be able to adapt new technology”. In Figure 4.11 also indicates 1.2% of the respondents (with the exception of patients) opt for “System should adhere all levels of interoperability and 19.2 % of the respondents (with the exception of patients) opt for “all of the aspects”. The finding observed is that GoT-HoMIS and AFYACARE were installed locally and have not been centralized. These two systems operate under a local area network (LAN). The systems do not exchange information; hence they are not interacting with each other.

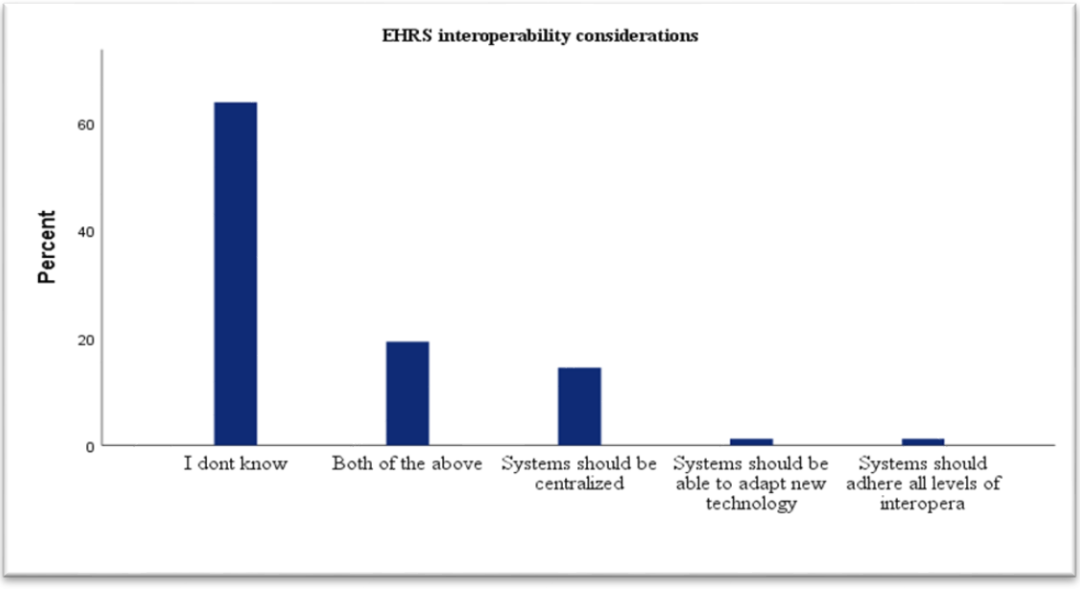


**Figure 4.11: EHRS Interoperability Consideration, by (Field Data 2023)**

### 4.5.3 Interoperability Architectural Approaches Suited for EHRS

Based on the number of EHRS that need to be interoperable, different architectures can be selected to build the systems. There are different architectural approaches for achieving interoperability between systems (Lopes, 2019). Three main approaches are point to point, hub and spoke, and enterprise service bus(ESB). Therefore these three aproaches are asked in the question in order to get respondents concerns. Figure 4.5.3 mentions three main architectural approaches that can be used for the interoperability of GoT-HoMIS and AFYACARE. In this case, 13.25% of the respondents (with the exception of patients, medical data clerks, and medical doctors), opt for “point to point”. 8.43% of the respondents (with the exception of patients, medical data clerks, and medical doctors) opt for “enterprise service bus” and 8.43% of the respondents (with the exception of patients, medical data clerks and medical doctors) opt for “all of the architecture that was mentioned. In addition, figure 4.12 indicates that 7.23% of the respondents opt for “hub” and 62.6% of the respondents (with the exception of patients, TAMISEMI, and IT system administrators) opt for “I don’t know”. The analysis reveals that the interoperability architectural approaches that can be used depend on the number of EHRS that need to be interoperable. If only two EHRS need to be interoperable, point-to-point or hub architectural approaches can be applied, and in the case of more than two EHRS, an enterprise service bus is a recommended option.

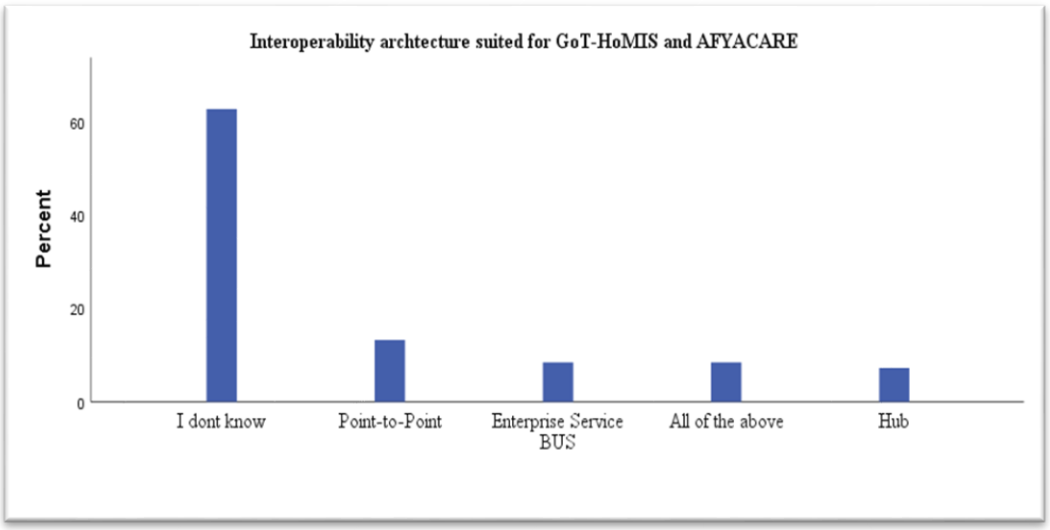


**Figure 4.12: Interoperability Architecture Approach suited for EHRS, by (Field Data 2023)**

### 4.5.4 The presence of the government electronic service bus (Gov-ESB) in solving EHRS interoperability issues

In this study, analysis of the government electronic service bus (Gov-ESB) was conducted via interview (TAMISEMI) and questionnaire. Since this was a technical issue, there were no other respondents except the ICT analyst and administrators from TAMISEMI and Iringa Regional Referral Hospital respectively.

The Gov-ESB was developed as middleware for data exchange between different systems. Currently, most of the connection is in point-to-point integration, as shown in the figure below.

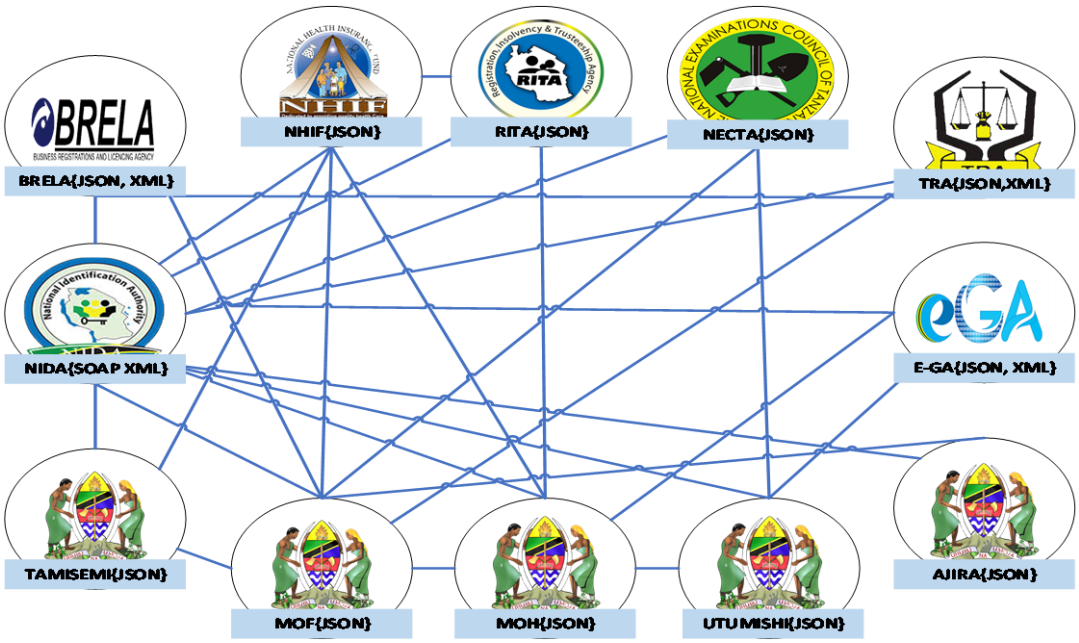


**Figure 4.13: Point to Point Integration, by (eGA 2023)**

This approach faces challenges including multiple links, data format, interoperability, and security. Some of the systems due to infrastructure issues were also not able to connect to each other. Therefore, due to the challenges that arose in point-to-point integration, Gov-ESB was developed to overcome the challenges. Gov-ESB enables data sharing between systems, including EHRS. In this aspect, any system that needs to get or share data from another does so via Gov-ESB, as shown in Figure 4.14

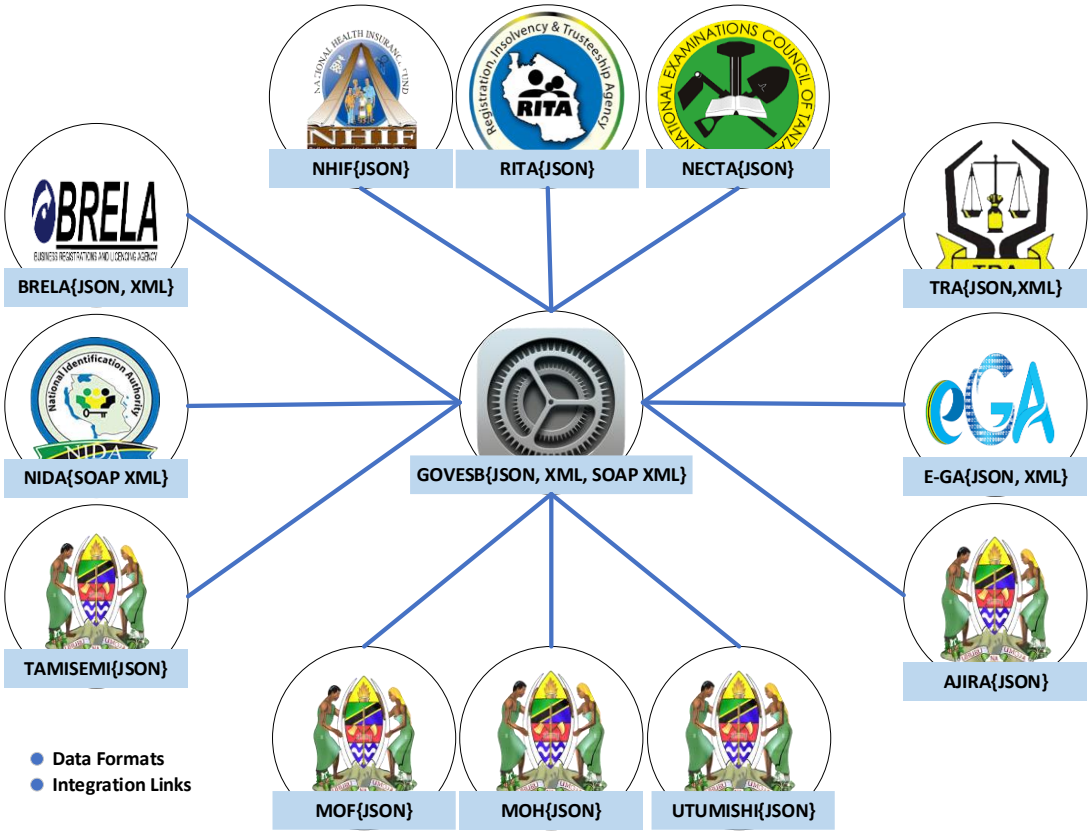


**Figure 4.14: Integration via Gov-ESB, by (e-GA 2023)**

Therefore, the interview performed in TAMISEMI and Iringa regional referral hospitals with an IT system analyst, revealed that despite the fact that there are many benefits for the systems in joining with Gov-ESB; there are still challenges that might hinder other government systems from joining and exchanging data with other systems, including EHRS like GoT-HoMIS and AFYACARE. Some of the challenges, include technical capacity, connectivity issues, in some of the organisations Gov-ESB is not a priority, there is no access to source code, there is no testing environment, some of the systems are not in production, and some organisations delay in making decisions. The analysis has also revealed that there are

conditions needed for an organisation to meet in order for EHRS to join with Gov-ESB, and one of it is that, the systems should be centralised and hosted in one of the authorised data centres (e-GA, 2016). The study reveals that, AFYACARE and GoT-HOMIS have not yet centralised and they have been locally hosted in the health premises, hence, they cannot join with Gov-ESB to accomplish interoperability, and for the moment, they will continue facing interoperability issues.

## 4.6 Proposed Electronic Health Records (EHR) System 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, organisation 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. Figure 4.15 shows the proposed electronic health record systems (EHRS) interoperability framework for government hospitals.

### 4.6.1 Organisation Process

Organisation components include leadership and governance, legislation, policy, and organisational considerations to enable the secure, seamless, and timely communication and use of data both within and between organisational entities, and individuals (Pardo & Burke, 2019).

Leadership and governance provide for the necessary decision-making that gives direction to and oversees interoperability initiatives. It also provides the necessary

political leadership and facilitates engagement with relevant stakeholders (ITU, 2015). In the organization process, stakeholders from various organisation with different aims, regulations, and requirements address non-technical aspects of EHRS interoperability, such as policy, legal, social, and organisation considerations.

Legal, policy, and investment are places where privacy, security, and confidentiality of healthcare information were identified as factors affecting wide spread adoption of EHRS interoperability. Therefore, an appropriate legal framework should be considered and has to be addressed through the creation of an appropriate legal framework, that can support the effective exchange of healthcare information (WHO, 2016). In addition to that, there should be policies that address e-health interoperability and mechanisms to ensure compliance with interoperability policies.

### 4.6.2 Electronic Health Record (EHR) Data Format and Standards

This component comprises two important data-formatting standards, which include syntactic, and semantic formatting data standards. Due to the presence of heterogeneous EHRS in healthcare facilities, data standards are required among different health sectors. Data health standards enable EHRS and devices to exchange data successfully. Syntactic data format standards define the format, syntax, and organisation of data exchange. It depend on message format standards to support the exchange of health data from one EHRS to another while maintaining the meaning of the data. In this aspect, sending and receiving data in EHRS must use the same data format standard to achieve interoperability. Syntactic data format standards include Health Level 7 (HL7), Clinical Document Architecture (CDA). Statistical Data and

Meta Data Exchange Health Domain (SDMX-HD), and Fast Healthcare Interoperability Resources (FHIR) (ITU, 2015). Other syntactic data standard include, Digital Imaging and Communication in Medicine (DiCOM). This facilitates the exchange of digital medical diagnostic images such as ultrasound, computed tomography (CT)scans magnetic reasonable imaging (MRI), between and imaging equipment and other healthcare applications (National Electronic Manufacturer Association, 2018).

Semantic data standards enable different EHRS to exchange data accurately with a common format and meaning. The standards involve clinical terminologies such as Systemized Nomenclature of Medicine Clinical Term (SNOMED CT), International Classification Disease (ICD), and Logical Observation Identifier Names and Codes (LOINC) (SDMK-HD, 2017). Both GOTHOMIS and AFYACARE use ICD for disease diagnosis purposes.

These languages provide standardised meanings of concepts to ensure that data is not only transferred accurately and interpreted meaningfully, but also used in a clinically relevant manner. Through semantics, different EHRS can exchange patient information through a common understanding of medical terminology. (WHO, 2016).

### 4.6.3 EHRS Infrastructure

Infrastructure establishes the interconnectivity requirements needed for one system or application to securely communicate data to and receive data from another.

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. In the finding, it was observed that technical infrastructure was among the major factors hindering EHRS interoperability.

In the hospitals where GOT-HOMIS and AFYACARE were installed there was insufficient ICT infrastructure. In this aspect, we need to consider network infrastructure, bandwidth, host environment, database applications, and network security applications. To support and operate in EHRS interoperability, a strong network infrastructure with a bandwidth of 60 to 100 Mpbs is required.

Reliable environment can be maintained by installing reliable primary and backup power supplies. A power backup solution that include Uninterruptable Power Supply (UPS), a standby power generator, and a solar power system that can power all main network devices for at least 10 hours. The network infrastructure includes a local area network (LAN), a wide area network (WAN), and internet connectivity with good cabling.

### 4.6.4 Information Security and privacy

Information security defines the level of authorization and authentication done for any updates performed on the data. To achieve fully interoperability, who has access

to the system (authentication) and who has access to specific areas of the system (authorization) should be clear to cater for security, which, if implemented very well, enhances privacy. The sensitivity of the patient's health records demands the highest level of privacy and security. The objective of data security is to ensure that there is no compromised EHRS data.

### 4.6.5 Interface Engine (Application Programme Interface (API))

These interfaces facilitate communication and data exchange between two or more different systems. According to (Hassel bring, 2000) there are about three dimensions of an information system, that must be taken into account namely, autonomy, heterogeneity, and distribution.

Application programming interface (API) specifies how software applications interact with each other regardless of the platform where these applications are reading (Data &Cyprian 2014). APIs allow different applications to request information from each other and use each other's facilities. This can be implemented using middleware technologies, which are web-based technologies such as SOAP, REST based services, or higher level programming languages. SOAP and WSDL are XML–based protocols that support both the exchange of information and service communication (Erl T, 2005).

XML is a notation readable by both humans and machines that permits the definition of structured data such that text is marked with a meaningful and unique identifier. Technologies used in XML and their roles in web services include:

- SOAP, which is a standard that allows for exchanging messages, hence supporting the existence of communication between services. It achieves this by defining the optional and critical components of messages that are exchanged between services.
- Web service definition language (WSDL), which is standard for defining service interfaces. It clearly marks out how the service operations and bindings ought to be defined.
- WS-BPEL is a workflow language standard that defines the process programmes that involve a number of different services.

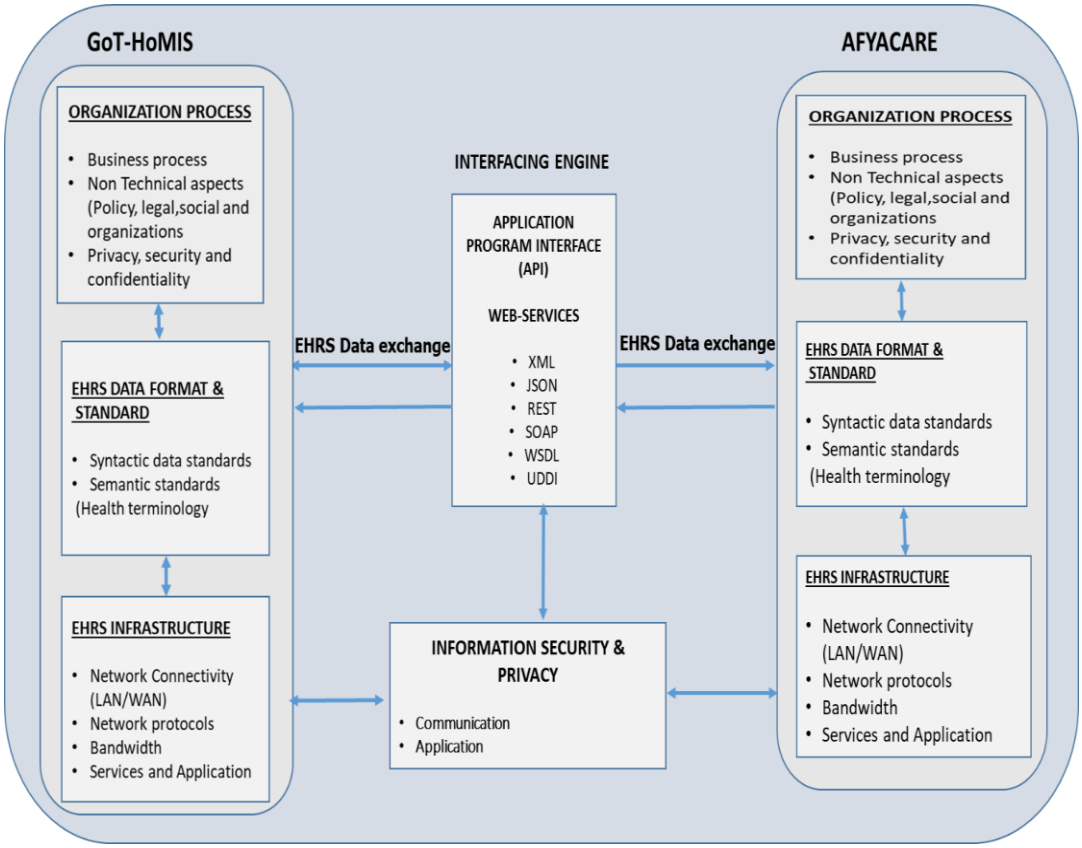


**Figure 4.15: Electronic Health Records (EHR) System interoperability framework, by (Field Data, 2023)**

## 4.7. Evaluating Electronic Health Records (EHR) Systems Interoperability Framework

The fourth objective of the study was to evaluate the developed electronic health record (EHR) system interoperability frame for the purpose of getting insight into whether the framework has met the requirements and can be applied to solving current EHR interoperability issues.

In this aspect an expert survey was used in evaluating the framework through a questionnaire, the designed based on the following facts.

- Awareness of the current EHR interoperability challenges
- The extent to which the developed HER interoperability framework has covered
- The need of the developed HER interoperability for achieving a successfully EHR interoperability
- Ranking of the developed EHR interoperability framework

Descriptive analysis used to analyze the collected evaluated data from respondents. Below are the findings of the evaluated EHR framework.

### 4.7.1 Awareness of the EHR Interoperability Challenges

From Figure 4.16, statistics indicate that 85% of the respondents know the EHR interoperability challenges, while 12.9% are not aware of them. This reveals that the majority of respondents involved in evaluating EHR interoperability framework were familiar with the EHR interoperability challenges.

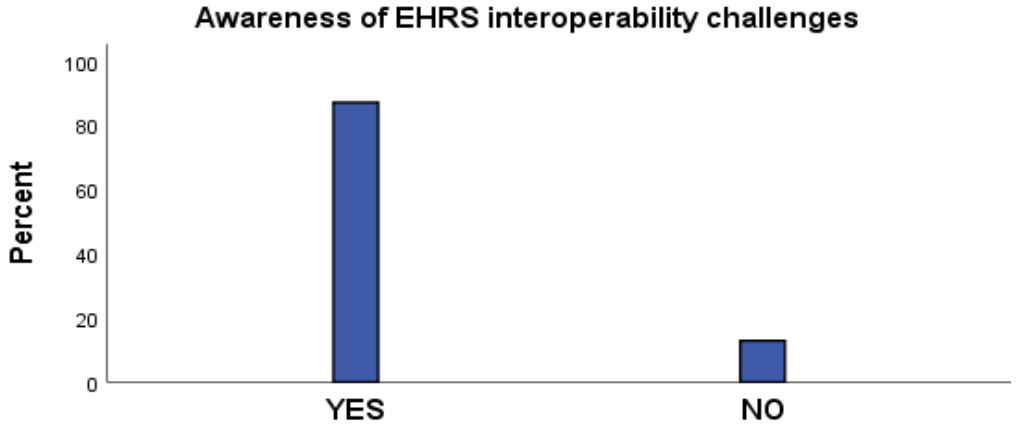


**Figure.4.16. Awareness of EHRS Interoperability Challenges, by (Field Data, 2023)**

### 4.7.2 Developed EHR Interoperability Framework Coverage Status

In this aspect, the study wanted to evaluate the framework in terms of the EHRS interoperability challenges that has covered. From Figure 4.17, the statistics indicate that 90.3 % of respondents have responded to full coverage, while 9.7% of others have responded to partial coverage. This reveals that the developed EHRS interoperability framework has covered many EHRS interoperability challenges.

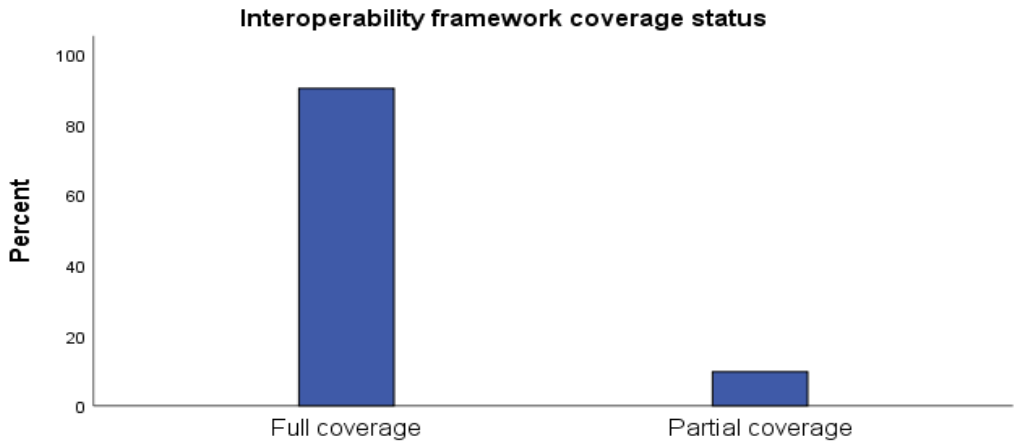


**Figure 4.17 EHRS Interoperability Framework Coverage Status, by (**Field data, 2023)

### 4.7.3 The need of EHRS Interoperability Frameworks for Achieving Successfully EHRS Interoperability

The study wanted to evaluate if the developed EHRS interoperability framework is needed for achieving successfully EHRS interoperability. In Figure 4.18, the statistic indicates that 58.1% of the respondents strongly agree and 32.3% of the respondents agree with the framework to be used in achieving EHRS, while 9.7% of respondents disagree. This reveals that the developed EHRS interoperability frame can be used as a guideline for successfully EHRS interoperability.

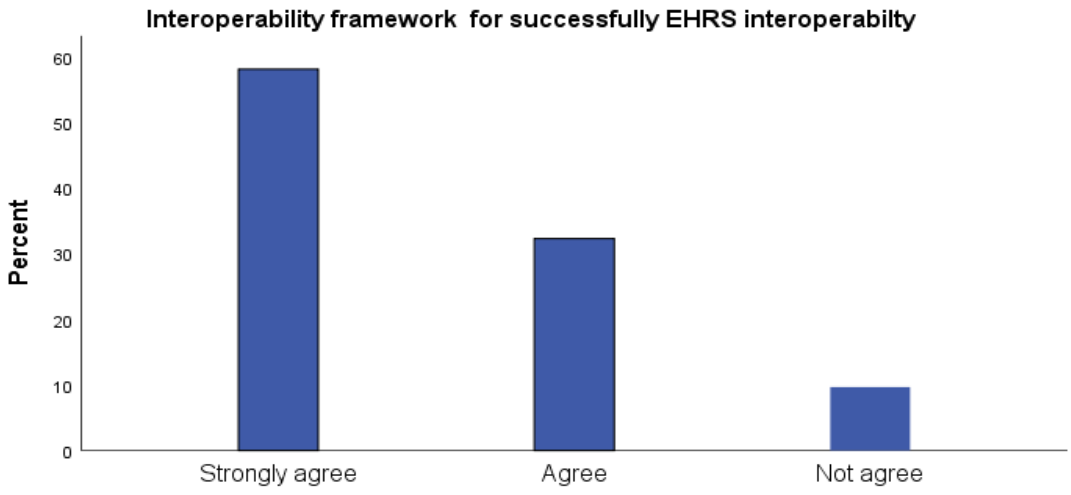

**Figure 4.18. The Need of EHRS Interoperability Framework for Achieving Successfully EHRS Interoperability, by (**Field data, 2023)

### 4.7.4 Rating of the Developed EHRS Interoperability Framework

The study also wanted to evaluate the EHRS interoperability framework, rating it, and see how much the framework is acceptable. From Figure 4.19, the statistics indicated that 71.3% of the respondents rate it at a 90-100 score, 16.1% of the respondents rate it at a 61-90 score, and the rest, which is 12.9% of the respondents rate it at a 31-60 score. This reveals that the developed EHRS interoperability framework is acceptable and can be applied as guidance for EHRS interoperability deployment.

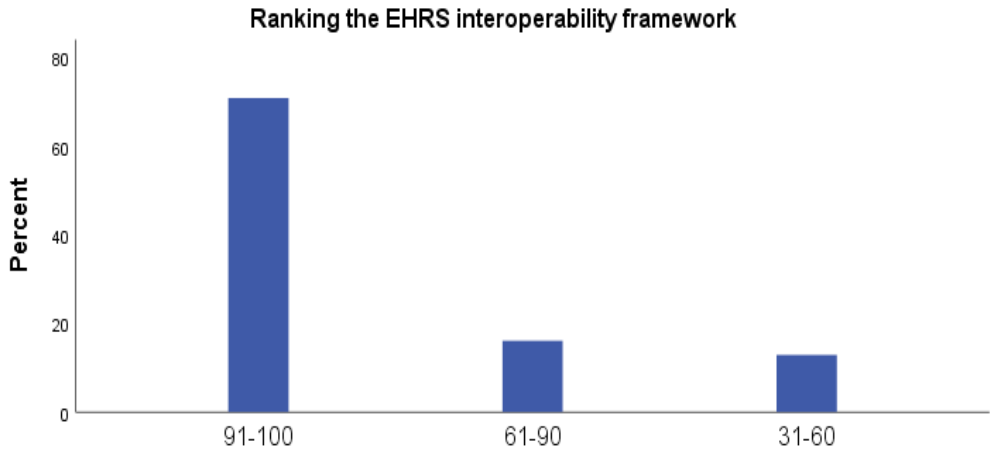


**Figure 4.19: Ranking of the Developed EHRS Interoperability Framework ,by (Field Data,2023)**

# CHAPTER FIVE

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

This study has aimed to develop an EHRS interoperability framework for government hospitals in Iringa. This chapter provides the conclusion of the study based on the set of objectives, recommendations derived throughout the course of this research, and future work as far as it relates to this study area.

## 5.2 Conclusions

The general objective of this study was to develop the electronic health record (EHR) system interoperability framework for the government hospitals in Iringa. The four specific objectives under this study, were as follow: - 1. To identify standard parameters adopted in existing health records in GOT-HoMIS and AFYACARE at Kilolo district hospital and Iringa referral regional hospital, respectively. 2. To review interoperability challenges in health records sharing between Kilolo district hospital and Iringa referral hospital, respectively. 3. To develop an electronic health

record (EHR) system interoperability framework, and 4. To evaluate the electronic health records (EHR) system interoperability framework.

The findings from this study, presented in Chapter 4 have shown that the interoperability of electronic health record (EHR) systems should take into consideration five issues, which include organisation aspects, infrastructure, data format and standards for health care services, security, and interface engines. Findings assist the researcher in coming up with the developed 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 organisation process tend to become barriers to interoperability for GoT-HOMIS and AFYACARE. Both AFYACARE and GoT-HOMIS have been installed locally and are not yet centralized.

This reveals that the interoperability framework that was developed should consider organisation, infrastructure, and health data standards components in order to solve the existing EHRS interoperability issues. 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 patients 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.

### 5.3 Recommendation

EHRS interoperability is vital since it allows for faster processes in healthcare delivery also helping to reduce costs on the patient side. Therefore, the following have been recommended in order to ensure successful EHRS interoperability.

- Both AFYACARE and GoT-HOMIS should be centralised, operated online, and accessed via the internet in order to easily facilitate interoperability.
- We need to have an appropriate EHRS interoperability architecture for only government hospital-related data. For interoperability of two or more EHRS Enterprise Application Integration architectural approaches can be applied.
- Health data format and standards should be well implemented for proper EHRS interoperability.
- Proper health data sharing policy is required to safe guard the privacy and security of the patient data

### 5.4 Future Works

The study was based on developing of an EHRS interoperability framework for government hospitals. Other studies can be conducted to develop and implement dedicated EHRS interoperability application suited only to government hospitals.

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# APPENDICES

## Appendix 1: Questionnaire Guideline for (EHRS Data Clerk, ICTStaff, and Medical Doctors)

My name is Yahya A. Kamba. I am a student in the Faculty of Science, Technology, and Environmental Studies at the Open University of Tanzania, pursuing a Master of Science in Information Technology and Management. I'm doing research entitled **INTEROPERABILITY FRAMEWORK FOR THE ELECTRONIC HEALTH RECORDS (EHR) SYSTEMS FOR THE GOVERNMENT HOSPITALS IN IRINGA REGION** as a partial fulfilment of my study. This questionnaire/interview aim to collect data regarding developing an interoperability framework for electronic health records systems for government hospitals. So please I need your cooperation.

**SECTION A: About yourself**

Q1: Enter your full name

Your answer

Q2: Choose your age group

i. 20-30 [ ]

ii. 31-35 [ ]

iii. 36-40 [ ]

iv. 41-45 [ ]

v. 45-59 [ ]

Q3: Specify Gender

i. Male [ ]

ii. Female [ ]

Q4: Specify your Position

Your answer

Q5: Your Organization

Your answer

Q6: Working experience

i. 1-5 [ ]

ii. 6-10 [ ]

iii. 11-20 [ ]

iv. 21-30 [ ]

Q7: Number of institutions ever worked for

i. 1 [ ]

ii. 2 [ ]

iii. 3 [ ]

iv. 4 [ ]

v. 5 [ ]

vi. Above 5 [ ]

Q8: Your education level

i. O-level Certificate [ ]

ii. A-level Certificate [ ]

iii. Diploma [ ]

iv. Advance Diploma [ ]

v. Bachelor Degree [ ]

vi. Post-Graduate Diploma [ ]

vii. Masters degree [ ]

viii. PhD [ ]

Q7: Experience in dealing with Electronic Health Records (EHR) Systems

i. 1-3 [ ]

ii. 4-6 [ ]

iii. 7-10 [ ]

iv. 11-20 [ ]

**SECTION B: STANDARD PARAMETERS ADOPTED IN EXISTING HEALTH RECORDS IN GOTHOMIS AND AFYACARE RESPECTIVELY**

**QN 1: Which of the following Electronic Health Records (EHR) Systems are you familiar with**?

i. GOTHOMIS [ ]

ii. AFYACARE [ ]

iii. JEEVA [ ]

iv. EHMS [ ]

v. MEDIPRO [ ]

vi. DHS [ ]

**SECTION B**

Q2: The following health records parameters exist in the GOTHOMIS /AFYACARE which include the ***Patient's full name, Age, Date of birth, Tribe, Marital status, Mobile no, Residence, Nationality, and Next of kin***

i. Agree [ ]

ii. Strongly agree [ ]

iii. Satisfied [ ]

iv. Disagree [ ]

v. I don't know [ ]

**SECTION B:**

QN3: The following information can be accessed from the Electronic Health Record (EHR) Systems (GOTHOMIS/AFYACARE)

i. Patient details [ ]

ii. Patient Diagnostic information [ ]

iii. Patient prescription information [ ]

iv. Patient Financial information [ ]

v. Both of the above [ ]

**SECTION C: INTEROPERABILITY CHALLENGES IN ELECTRONIC HEALTH RECORDS SHARING BETWEEN DIFFERENT ELECTRONIC HEALTH RECORDS (EHR) SYSTEMS**

QN1: The following are among of the challenges experienced by patients when referred from one hospital to another if the (EHR) systems are not interoperable which include ( ***Unnecessary cost due to repetition of the diagnosis process, delay in acquiring the patient previous information and delay in delivering health service to the patients)***

i. Agree [ ]

ii. Disagree [ ]

iii. Strongly agree [ ]

iv. Satisfied [ ]

v. Not known [ ]

**SECTION C**

QN2: Is there any system that currently supports information sharing (acts as a mediator) between different electronic health records (EHR) Systems that are in place in Government Hospitals

i. YES [ ]

ii. NO [ ]

iii. I DONT KNOW [ ]

SECTION C

QN 3: To accomplish the interoperability of the two heterogeneous (EHR) Systems, four levels of interoperability should be adhered which include ***organization, syntactic, semantic, and technical levels)***

i. Agree [ ]

ii. Disagree [ ]

iii. Strongly agree [ ]

iv. Strongly disagree [ ]

v. I don't know [ ]

SECTION C:

QN 4: Which of the following are among of the key challenges that cause Electronic Health Records (EHR) systems like ***GOTHOMIS*** and ***AFYACARE*** not interoperable

i. Technical Issues (Infrastructure) [ ]

ii. EHR-Systems Health Standards [ ]

iii. Organization Policies and Agreement [ ]

iv. Technology applied in developing EHR Systems [ ]

v. Both of them [ ]

vi. I don't know [ ]

SECTION C

QN 5: For the systems to be interoperable, both systems should adhere the following

i. Systems should be centralized [ ]

ii. Systems should be able to adapt to new technology [ ]

iii. Systems should adhere to all levels of interoperability [ ]

iv. Both of the above [ ]

v. I don't know [ ]

SECTION C

QN 6:

Which of the following interoperability architectures is the best to use in case of developing interoperability of two systems like GOTHOMIS and AFYACARE

i. Enterprise Service BUS [ ]

ii. Point-to-Point [ ]

iii. Hub and Spoke [ ]

iv. All of the above [ ]

v. I don't know [ ]

**SECTION C**

QN 7: The Government Electronic Service Bus (GOV-ESB) is one of the current applications developed by e-GA for the purpose of making different Government institutions exchange and use their information. Will this solution solve the interoperability challenges that currently facing Electronic Health Records Systems like GOTHOMIS and AFYACARE?

i. YES [ ]

ii. NO [ ]

iii. I DON'T KNOW [ ]

**SECTION C**

QN8:

If the answer above (7) is "NO" Why do you think Gov-ESB will not solve the challenges of interoperability of electronic health record systems

……

……

……

……

**Research Clearance Letter**

# THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

**THE OPEN UNIVERSITY OF TANZANIA**

**Ref. No OUT/PG202000689** **16th August, 2023**

Managing Director,
Kilolo District Hospital,
P.O.Box 2324,
**IRINGA.**

Dear Managing Director,

**RE: RESEARCH CLEARANCE FOR MR. YAHYA ALLY KAMBA, REG NO: PG202000689**

2. The Open University of Tanzania was established by an Act of Parliament No. 17 of 1992, which became operational on the 1st March 1993 by public notice No.55 in the official Gazette. The Act was however replaced by the Open University of Tanzania Charter of 2005, which became operational on 1st January 2007.In line with the Charter, the Open University of Tanzania mission is to generate and apply knowledge through research.

3. To facilitate and to simplify research process therefore, the act empowers the Vice Chancellor of the Open University of Tanzania to issue research clearance, on behalf of the Government of Tanzania and Tanzania Commission for Science and Technology, to both its staff and students who are doing research in Tanzania. With this brief background, the purpose of this letter is to introduce to you **Mr. Yahya Ally Kamba, Reg.**

**No: PG202000689),** pursuing **Masters of Science in Information Technology Management (Msc-ITM).** We here by grant this clearance to conduct a research titled **"Interoperability Framework for Electronic Health Records (EHR) Systems for Tanzania Government Hospitals in Iringa Region"**. He will collect his data at your office from 17th August to 31th September 2023.

4. In case you need any further information, kindly do not hesitate to contact the Deputy Vice Chancellor (Academic) of the Open University of Tanzania, P.O.Box 23409, Dar es Salaam. Tel: 022-2-2668820.We lastly thank you in advance for your assumed cooperation and facilitation of this research academic activity.

Yours sincerely,

**THE OPEN UNIVERSITY OF TANZANIA**

Prof. Magreth S.Bushesha

**For: VICE CHANCELLOR**

# THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

**THE OPEN UNIVERSITY OF TANZANIA**

**Ref. No OUT/PG202000689** **16th August, 2023**

Medical Officer In charge,

Iringa Regional Referral Hospital,

P.O.Box 260,

**IRINGA.**

Dear Medical Officer In charge,

**RE: RESEARCH CLEARANCE FOR MR. YAHYA ALLY KAMBA, REG NO: PG202000689**

2. The Open University of Tanzania was established by an Act of Parliament No. 17 of 1992, which became operational on the 1st March 1993 by public notice No.55 in the official Gazette. The Act was however replaced by the Open University of Tanzania Charter of 2005, which became operational on 1st January 2007.In line with the Charter, the Open University of Tanzania mission is to generate and apply knowledge through research.

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**No: PG202000689),** pursuing **Masters of Science in Information Technology Management (Msc-ITM).** We here by grant this clearance to conduct a research titled **"Interoperability Framework for Electronic Health Records (EHR) Systems for Tanzania Government Hospitals in Iringa Region"**. He will collect his data at your area from 17th August to 31th September 2023.

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Yours sincerely,

**THE OPEN UNIVERSITY OF TANZANIA**

Prof. Magreth S.Bushesha

**For: VICE CHANCELLOR**

# THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

THE OPEN UNIVERSITY OF TANZANIA

**Ref. No OUT/PG202000689** **30th August, 2023**

Permanent Secretary,

President's Office, Regional Administration and Local Government (PORALG),

P.O.Box 1923,

**DODOMA.**

Dear Permanent Secretary,

**RE: RESEARCH CLEARANCE FOR MR. YAHYA ALLY KAMBA, REG NO: PG202000689**

2. The Open University of Tanzania was established by an Act of Parliament No. 17 of 1992, which became operational on the 1st March 1993 by public notice No.55 in the official Gazette. The Act was however replaced by the Open University of Tanzania Charter of 2005, which became operational on 1st January 2007.In line with the Charter, the Open University of Tanzania mission is to generate and apply knowledge through research.

3. To facilitate and to simplify research process therefore, the act empowers the Vice Chancellor of the Open University of Tanzania to issue research clearance, on behalf of the Government of Tanzania and Tanzania Commission for Science and Technology, to both its staff and students who are doing research in Tanzania. With this brief

background, the purpose of this letter is to introduce to you **Mr. Yahya Ally Kamba, Reg. No: PG202000689),** pursuing **Masters of Science in Information Technology Management (Msc-ITM).** We here by grant this clearance to conduct a research titled **"Interoperability Framework for Electronic Health Records (EHR) Systems for Tanzania Government Hospitals in Iringa Region"**. He will collect his data at your office from 31st August to 31th September 2023.

4. In case you need any further information, kindly do not hesitate to contact the Deputy Vice Chancellor (Academic) of the Open University of Tanzania, P.O.Box 23409, Dar es Salaam. Tel: 022-2-2668820.We lastly thank you in advance for your assumed cooperation and facilitation of this research academic activity.

Yours sincerely,

**THE OPEN UNIVERSITY OF TANZANIA**

Prof. Magreth S.Bushesha

**For: VICE CHANCELLOR**

THE NATIONAL REPUBLIC OF TANZANIA
PRESIDENT OFFICE
REGIONAL ADMINSTRATION AND LOCAL GOVERNMENT
KILOLO DISTRICT COUNCIL

*Telephone:0262968010*
*Fax:0262968010*
*Website:www.kilolodc.go.tz*
*Email:ded@kilolodc.go.tz/ded.kilolo@iringa.go.tz*

*S.L.P2324,*
*KILOLO.*
*Tanzania*

Ref. No. KDC/S. IO/VOLL. VIV 181 11 th September, 2023

MR. YAHYA ALLY KAMBA,
THE OPEN UNIVERSITY OF TANZANIA, P.O.BOX 23409,
DAR ES SALAAM

RE: PERMISION TO CONDUCT RESEARCH

Reference is made to the above subject.

2. I would like to inform you that, the District Executive Director's office has granted permission to you to conduct your research on "INTEROPERABILITY FRAMEWORK FOR ELECTRONIC HEALTH RECORDS (HER) SYSTEMS FOR TANZANIA GOVERNMENT HOSPITALS IN IRINGA REGION" from 17th, Augost, 2023, to 31 st September 2023.

3. I wish you all the best.

Hilary Chota
For District Executive Director
**KILOLO**

KILOLO DISTRO EXECUTIVE DIRECTOR
c.c THE VICE CHANCELLOR,
THE OPEN UNIVERSITY OF TANZANIA, P.O.BOX 23409,
DAR ES SALAAM
District Medical
Officer KILOLO.

THE UNITED REPUBLIC OF TANZANIA

PRESIDENT'S OFFICE

# REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

Telegrams "TAMISEMI"
Telephone No. +255 26
+255 26 2322116P.O. Box 1923,
E-mail: ps@tamisemi.go.tz41185
In reply please quote:
Ref. No. AB.99/178/01/105

DODOMAGovernment City - Mtumba
2321607TAMISEMI Street, Fax No.
DODOMA.

25th September 2023

Vice Chancellor,
The Open University of Tanzania,
P.O. Box 23409,
DAR ES SALAAM.

Re: REQUEST FOR RESEARCH CLEARANCE

Kindly refer to your letter with reference no Ref. OUT/PG202000689 dated 30 August, 2023, you requested to conduct research as described above.

2. I'm glad to inform you that, Mr. Yahya Ally Kamba, Reg. No. PG202000689 have been granted permission to conduct the aforementioned research from 31 st August, 2023 to 31 st September 2023 in the Department of Information and Communication Technology (DICT).
3. It should however be understood that, during the research PO — RALG, will not be able to offer any payment in respect of the student being here.
4. We thank you for your cooperation.

Josep. A. Feruzi
For: PERMANENT SECRETARY

Cc: Director,
Information and Communication Technology,
PO - RALG.

Mr. Yahya Ally Karnba

THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF HEALTH

IRINGA REGIONMedical Officer In charge,
Kinondoni Street, Tel:026270226ÇP.O.Box260,.
Faxno:0262702264
IRINGA.

In reply please quote:
Ref. No. IRRH/E.10/16N01. XXXII/8 24th August,2023

Vice Chancellor,
The Open University of Tanzania P. O.
Box 23409,
DAR ES SALAAM.

REF: PERMISSION TO CONDUCT RESEARCH AT IRINGA REGIONAL REFERRAL HOSPITAL.

Refer to the heading captioned above and a letter with Ref. No. OUT/PG202000689 dated 16rd August 2023.

2. I am glad to inform you that permission has been granted to your student Yahya Ally Kamba to conduct research at Iringa Regional Referral Hospital. Research titled "Interoperability Framework for Electronic Health Records (HER) System for Tanzania Government Hospitals in Iringa Region".

3. It is my sincere hope that ethical issues and hospital protocols shall be observed.

4. Thanks for your cooperation.

Dr. Alfred M. Laison

Medical Officer Incharge
Iringa Regional Referral Hospital
IRINGA