Evaluating Free and Open Source Radiology Information System for Automating Workflows at The University Teaching Hospitals - Zambia

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Abstract

In Zambia, the public health sector faces a significant shortage of qualified radiologists, with only few serving a population of 20 million people as of 2023. The negative impact this has had on the radiological workflows is quite profound. In addition to this challenge, is the manual process involved in patient registration, requesting for a modality scan, assigning patient to imaging room as well as writing of reports on interpreted medical images, etc. Thus, the intent of our study was to discover a Free and Open Source Radiology Information System, for automating radiological workflows. A mixed method approach was adopted in collecting both qualitative and quantitative data, here interviews, observations and archival record analysis was conducted to understand the radiological workflows, challenges and collect requirements which guided the discovery and selection of a FOSS RIS platform. A comparative analysis of two main FOSS RIS platforms was undertaken i.e OpenMRS Radiology Module and LibreHealth RIS. Eventually, we adopted OpenMRS with the radiology module and tested its usability or ease of use using the System Usability Scale (SUS). The SUS score grade for the overall usability of the system came out at 79% which is between 68% - 80.3% giving an adjectival rating of Good thereby recommending the adoption of the system at the UTHs radiology department. In conclusion, our research has shown that adopting a FOSS Radiology Information System is a viable solution towards automating radiological workflows in the health sector.

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List of Acronyms and Abbreviations

Abbreviation	Description
DICOM	Digital Imaging and Communications in Medicine
EMI	Enterprise Medical Imaging
HL7	Health Level 7
NHIMA	National Health Insurance Management Authority
RIS	Radiology Information System
UNZA	The University of Zambia
UTHs	University Teaching Hospitals

1. Introduction

Medical imaging plays a crucial role in the diagnosis and treatment of diseases. In Zambia, the public health sector has been facing significant challenges in managing and interpreting medical images due to a shortage of qualified radiologists [1]. These challenges have been compounded by the increasing use of medical imaging modalities and subsequent growth in imaging data. The lack of proper management and interpretation of medical images has led to misdiagnosis, delayed treatment, and, in some cases, fatal consequences. Enterprise Medical Imaging (EMI) techniques, particularly the use of Radiology Information Systems (RIS), hold the potential to address these challenges.

The intent of this research was to evaluate the feasibility of adopting a Free and Open-Source Software (FOSS) RIS platform at the University Teaching Hospitals in Zambia towards automating radiological workflows. To this effect, various activities were undertaken. Following the objectives of our study, we first highlight work related to this research, understanding the gaps and thus giving motivation to carry on. Next, we take you through an in depth discussion of what we did to understand the challenges faced in radiological workflows at the UTHs and the results thereof. Then, we highlight the procedure we used to discover and adopt a FOSS tool for addressing the understood radiological challenges. Finally, we tested the usability of the discovered software and documented the results indicating the need to migrate from current radiological workflows at the UTHs to use of automated workflows through leveraging FOSS tools.

1.1. Study Background

In Africa, there are an average of 3.6 Radiologists per one million of the population [2], compared to an average of 120 Radiologists per one million of population in Europe and the United States of America. It is reported that, as of the year 2020, only 9 trained Radiologists practised in the public sector in Zambia against a population of 18 million [3]. What does this shortage say on the workload associated with the radiology department? The shortage of trained Radiologists is a global challenge, the situation is especially critical in developing countries [4]. To address this issue, potential solutions can be explored such as training of more radiologists; however, this comes with its own merits and demerits. Other options we seek to explore are thus related to automating some of the manual workflows currently being

practised with regard to patient registration, requesting for a modality scan and image acquisition through the use of FOSS radiology information systems. Though this does not solve the shortage problem, it however helps to reduce the turnaround time associated with radiological workflows, from manual to digital.

1.2. Problem Statement

The public health sector in Zambia faces significant challenges in managing and interpreting medical images due to a shortage of qualified radiologists and inadequate infrastructure [1]. The current radiology workflows in public health facilities in Zambia are manual, paper-based and prone to errors. Manual workflows range from requesting for examinations, communication between cadres, sharing of reports on interpreted medical images, linking medical images to requests, to mention a few. The increasing use of medical imaging modalities has resulted in a growing volume of imaging data that needs to be managed, interpreted, and reported on. This has led to significant delays in the delivery of medical imaging services, delayed diagnoses, and inadequate patient care. Furthermore, the lack of standardised processes has led to inconsistencies in reporting, making it difficult to track patient progress and make informed decisions.

1.3. Study Objectives

1.3.1. Broad Objective

To investigate the feasibility of leveraging an interoperable RIS platform for efficient and effective management of radiological tasks.

1.3.2. Specific Objectives

1.3.2.1. *To understand the workflows and challenges of the radiology department.*

1.3.2.2. *To identify a FOSS Radiology Information System.*

1.3.2.3. *To evaluate the usability of a FOSS Radiology Information System.*

1.3.3. Research Questions

1.3.3.1. *What are the primary workflows and challenges of a radiology department?*

1.3.3.2. *What FOSS Radiology Information System can be used in the health sector?*

1.3.3.3. *How usable is a FOSS Radiology Information System?*

1.4. Study Rationale

The purpose of this study was to evaluate the feasibility of adopting a Free and Open-Source Software (FOSS) RIS platform at the University Teaching Hospitals in Zambia towards automating radiological workflows. The study aimed to discover a FOSS RIS platform that can be used to reduce the time taken to interpret and report on medical images, and ultimately improve patient care. The evaluation of a FOSS RIS platform took into account discovering features including but not limited to compatibility, interoperability, extensibility and current community support of the RIS platforms.

Working towards the discoverability of a RIS platform, we worked closely with the radiology department staff to ensure that the system meets their specific needs and requirements.

1.5. Scope and Limitations

This study investigated the feasibility of adopting a FOSS RIS platform at the UTHs in Zambia to automate radiological workflows. The study focused on understanding the challenges faced by the radiology department, identifying suitable FOSS RIS platforms, evaluating their usability, and assessing their potential to improve efficiency and patient care.

1.5.1. Specific Scope:

- Geographical Scope: The study was conducted at the University Teaching Hospitals (UTHs) in Lusaka, Zambia.
- Temporal Scope: The study spanned from february, 2023 to November, 2023.
- Topical Scope: The study focused on the feasibility of adopting a FOSS RIS platform for automating radiological workflows at the UTHs.
- Methodological Scope: The study employed a mixed-methods approach, combining qualitative and quantitative methods. The qualitative component involved interviews and observations to understand the current radiological workflows and challenges. The quantitative component involved usability testing to evaluate the performance of FOSS RIS platforms.

1.5.2. Limitations:

- Sample Size: The study involved a relatively small sample UNZA students, which may limit the generalizability of the findings.
- Limited FOSS RIS Platforms: The study only evaluated a limited number of FOSS RIS platforms, which may not represent the full range of available options.
- Evaluation Timeframe: The usability evaluation was conducted over a short period, which may not provide a comprehensive assessment of the long-term usability of the FOSS RIS platforms.
- Focus of the research: The study primarily focused on the potential of FOSS RIS platforms to automate radiological workflows, while other aspects of patient care, such as image interpretation and reporting, were not extensively explored.
- Potential for Vendor Lock-in: Adopting a FOSS RIS platform may still lead to vendor lock-in, as the platform may require ongoing support and maintenance from the vendor.

1.5.3 Addressing Limitations:

Despite these limitations, the study provides valuable insights into the feasibility of adopting FOSS RIS platforms in Zambian healthcare settings. Future research could explore a more comprehensive evaluation of FOSS RIS platforms, including their impact on patient care, data security, and long-term sustainability. Additionally, studies could investigate the role of institutional factors, such as cultural change and leadership support, in facilitating the adoption and success of FOSS RIS platforms.

1.6. Ethical Considerations

While conducting our research, measures were undertaken to ensure compliance with ethical issues described in Appendix D. To effectively carry out our study, ethical clearance approval was sought from the following entities;

The University of Zambia Biomedical Research Ethics Committee (UNZA BREC), in a letter dated 5th May, 2022 with reference No.2731-2022 granted clearance to conduct the research.

The National Health Research Authority (NHRA), in a letter with reference No. NHRA000024/10/05/2022 granted clearance to conduct the research.

The Ministry of Health (MoH), in a letter dated 16th May, 2022 granted clearance to conduct the research.

The University Teaching Hospitals (UTHs), in a letter dated 5th September, 2022 granted clearance to conduct the research at the UTHs.

2. Related Work

2.1. Challenges with Radiological Workflows in Zambia

The challenge of low staffing levels associated with radiology workers has been well-documented in previous works, with the shortage said to be critical among Specialist Radiologists, Radiology Nurses, Nuclear Physicians and Medical Physicists [6]–[7]. Furthermore, Zulu et.al. highlights challenges to do with partially digitised imaging systems, increased workload, inefficient workflows, image storage and retrieval issues, disjointed departmental imaging services and limited expansion of the imaging sector beyond diagnostic services [4]. Though our study does not aim at addressing all these aforementioned challenges, we seek to identify a FOSS RIS to automate workflows associated with the radiology department at the UTHs.

2.2. Enterprise Medical Imaging (EMI)

EMI is a comprehensive framework that combines techniques, processes, and procedures to facilitate the efficient management of clinical medical imaging content within healthcare settings. Its primary goal is to seamlessly integrate technological components throughout the entire medical imaging workflow [8]. EMI not only consolidates radiological infrastructure and services but also accommodates various types of medical media. It holds the potential to improve clinical care and operational efficiency, especially as the range of imaging modalities expands and the need for faster interpretation of medical image reports becomes critical [4]-[5].

A successful EMI program comprises seven essential elements, including effective governance, a well-defined strategic plan, standards-based technological infrastructure, availability of clinical images, an enterprise image viewer, interoperable services for image exchange, and image analytics tools for reporting. Implementing EMI strategies comes with challenges, considering the diverse aspects involved, such as hardware, software, communication infrastructure, data sources, people, and procedures. Therefore, careful consideration of these elements is essential when executing an EMI strategy. [4]

EMI strategies and RIS implementations are often intertwined, as RIS plays a central role in managing and automating patient scheduling, image ordering, and report distribution.

Integrating EMI with RIS can improve the entire medical imaging workflow, enhancing efficiency and reducing administrative burdens.

By aligning EMI strategies with RIS implementations, healthcare organisations can achieve a more integrated and efficient approach to managing medical imaging data, ultimately improving patient care and operational outcomes.

While EMI offers numerous benefits, it is essential to acknowledge the potential challenges associated with its implementation. One critical challenge lies in the integration of diverse imaging modalities and data formats. Medical imaging encompasses a wide range of modalities, each with its unique data format and interpretation requirements. Integrating these diverse data sources into a unified EMI system can be a complex and time-consuming endeavour. Additionally, EMI implementation often requires significant financial investment in hardware, software, and training. Organisations must carefully evaluate the costs and benefits of EMI before embarking on such an undertaking.

In conclusion, EMI offers a promising approach to managing and analysing medical imaging data, enabling healthcare organisations to improve clinical care and operational efficiency. However, its implementation comes with challenges, requiring careful consideration of diverse aspects, including hardware, software, data formats, and integration with existing systems. By acknowledging these challenges and adopting a strategic approach, healthcare organisations can successfully implement EMI and reap its benefits.

2.3. Free and Open Source Software

Free and Open Source Software Free and Open Source Software (FOSS) represents a unique paradigm in the realm of software development and distribution, characterised by the principles of transparency, collaboration, and community-driven innovation. One of the primary strengths of FOSS is its accessibility. It is typically available at no cost, making it an attractive option for individuals, organisations, and even governments aiming to reduce software licensing expenses. Moreover, FOSS promotes transparency by allowing users to examine the source code, which fosters trust and accountability. Though it has limitations like absence of commercial support, our research will be based on evaluating FOSS RIS platforms

that have the potential to address challenges with radiological workflows at the UTHs in Zambia.

2.3.1. OpenMRS Radiology Module

The OpenMRS Radiology Module is an extension of the OpenMRS platform designed to support the management of radiology and imaging services in low-resource settings [9]. It offers features such as imaging order management, image acquisition and storage, image viewing and analysis, image reporting, quality control, and integration with other systems. However, OpenMRS has certain weaknesses that need addressing for the implementation of an interoperable RIS at public health facilities in Zambia. Its limited default functionality requires additional modules or custom development for advanced features, increasing complexity in low-resource settings. Interoperability challenges arise when integrating with other systems, hindering seamless data exchange. To overcome these limitations, the proposed RIS platform should prioritise simplicity of setup and configuration with an intuitive interface. It should provide comprehensive default functionality, including scheduling, billing, reporting, and inventory management, without extensive customization. Seamless integration with existing healthcare systems and adherence to international standards like DICOM [10] and HL7 [11] would ensure interoperability and bridge gaps in global health radiology.

2.3.2. LibreHealth Radiology Information System

LibreHealth Radiology, an open-source RIS developed as part of the LibreHealth project, aims to automate radiology workflows and enhance patient care [12]. It offers features like patient scheduling, image acquisition and storage, reporting tools, and workflow management. Customizable and compatible with DICOM, it promotes collaboration and integration with Picture Archiving and Communication Systems (PACS). While valuable, LibreHealth RIS has limitations that need addressing for low-resource settings like Zambia. Scalability and extensibility challenges may hinder adoption in larger facilities. Customization complexity and lack of user-friendly interfaces pose obstacles. Interoperability with existing systems requires further development. By addressing these limitations, the proposed RIS platform can effectively improve radiology workflows, enhance patient care, and bridge gaps in global health radiology in low-resource settings.

3. Methodology

3.1. Introduction

In this section, we are outlining the rationale behind the selection of specific approaches and explaining how they collectively contributed to the investigation of the feasibility of leveraging an interoperable RIS platform for efficient and effective management of radiological tasks. By leveraging the mixed-methods approach, we aimed to provide a holistic view of the current state of radiological practices, the challenges faced by healthcare professionals, and the existing documentations and processes relevant to the management of medical imaging data. This comprehensive approach informed the subsequent stages of our research and paved the way for the identification of a FOSS RIS to be used for automating radiological workflows at the UTHs radiology department.

3.2. Understanding Radiological Workflows and Challenges at UTHs

3.2.1. Participant Observations

A series of eight observation sessions took place on the grounds of the UTHs in Lusaka, Zambia from July 18th to July 22nd, 2023. This served as a crucial investigation of the main workflows and difficulties of the radiology department. We observed different key stakeholders at various workflow points including:

- Data Entry Clerks: responsible for accurately and efficiently entering patient information, maintaining correct patient records and ensuring compliance with data privacy regulations
- Cashiers: responsible for collecting payments for radiology services, ensuring financial transactions are processed smoothly and accurately
- NHIMA officers: responsible for ensuring compliance with the NHIMA guidelines and procedures, facilitating the processing of NHIMA claims, and providing administrative support to the radiology department.
- Referring physicians: responsible for ordering appropriate imaging studies based on patient history, physical examination, and clinical presentation. On the other hand, they are responsible for reviewing and interpreting imaging reports to provide accurate diagnoses and treatment plans as well as collaborating with radiologists to ensure optimal patient care.
- Radiographers: responsible for performing imaging procedures which include:

1. Positioning patients for various imaging modalities, such as X-rays, CT scans, and MRIs

2. Operating imaging equipment, ensuring proper technical parameters and safety protocols

3. Processing and developing imaging films or digital images

4. Maintaining patient records and ensuring adherence to radiation safety regulations

During the observations, each session lasted an average of one to two hours and they were carefully planned to reveal the complexities of daily operations. We took an unobtrusive attitude as the main observers so that the activities may continue in their natural rhythm. We systematically recorded crucial patient and staff interactions, task sequences, and essential actions in the radiology department using a checklist that was carefully created. The conclusions drawn from these observations were later condensed into a tabular format, which successfully captured the quantitative core of the operations.

With the aid of this observational methodology, we were able to understand the temporal dynamics and interactions between distinct tasks. In order to preserve a delicate balance between information collecting and imperceptibility, our interactions with participants were carefully adjusted. These findings, acting as a quantitative foundation, shed light on the complex web of radiology workflows and potential bottlenecks within the department's operations.

The research process moved closer to a qualitative layer after the foundation had been laid through these quantitative observations. Through upcoming interviews described in Section 3.2.3, we deepened our understanding and added the participants' first-hand accounts to our findings. Together, the combination of quantitative accuracy and qualitative insights promised to provide a thorough explanation of the dynamics of the radiology department. This comprehensive understanding made it possible to imagine automating pathways for a more productive future in addition to identifying potential improvements.

3.2.2. Document Analysis

The document analysis conducted as part of our research methodology served a dual purpose in enhancing the discovery of an efficient RIS as it not only facilitated the comprehension of the existing radiological data landscape at the UTHs. The primary objectives of this document analysis were:

3.2.2.1. Understanding Data Capture

We meticulously examined a range of documents and papers to gain comprehensive insights into the types of data captured within these records. The purpose was to identify the specific data points recorded in various radiological documents, some of which include: Radiological Request Forms, CT Reports, Mammography Reports, Register Books, Tally Sheets, Receipts, NHIMA Forms, Radiographer Books, Prescription Slips, Requisition Forms, and Case Logout Registers.

3.2.2.2. Identifying Data Issues

Beyond data capture, we also scrutinised the documents for potential data-related challenges. These included the identification of duplications, data redundancy, errors arising from manual data entry, and instances of data incompleteness. Identifying such issues was crucial, as it allowed us to envision how the RIS platform could play a pivotal role in mitigating these challenges and ensuring data accuracy.

3.2.2.3. Discovery of FOSS RIS Platform

By understanding the data captured in these documents, we aimed to inform the plan used in the identification of the RIS platform. The insights obtained from the document analysis were instrumental in identifying the essential data fields and parameters that the RIS should be capable of capturing and managing.

In summary, the document analysis was not only instrumental in comprehending the existing radiological data landscape but also played a pivotal role in shaping the discovery of a FOSS RIS.

3.2.3. Interviews

To further deepen our understanding of the radiology department's workflows, challenges, and the requirements for the discovery of a FOSS RIS, a series of in-depth interviews with

key staff members were conducted from the 9th to 10th October, 2023 at the UTHs. These interviews were an essential qualitative component of our research.

3.2.3.1. Participant Selection

Eight staff members, representing various roles within the radiology department, were selected as participants for the interviews. These roles included data entry clerks, cashiers, NHIMA officers, referring physicians, radiologists and radiographers. The choice of participants was intended to provide a comprehensive view of the UTHs radiology department's functions and challenges.

3.2.3.2. Interview Structure

In the interview sessions that were conducted, a semi-structured approach was employed, providing a flexible yet focused interaction with the participants. This allowed us to gather and gain more detailed information from the interview participants.

The interview questions that were conducted covered a range of topics, including but not limited to; the roles and responsibilities of the interview participants, the challenges the interview participants had and suggestions that the interview participants had concerning the features of the RIS.

3.2.3.3. Data Collection

Each interview session that was conducted was audio recorded with the consent of the participants. This method of data collection allowed us to capture the interviews accurately and ensured that no valuable information was lost.

3.2.3.4. Data Analysis

The audio recordings from the interviews were transcribed and analysed to extract qualitative insights. These insights complemented the quantitative data gathered from our earlier observations and the document analysis, providing a comprehensive understanding of the UTHs radiology department's operations, challenges and requirements.

The combination of quantitative and qualitative data from observations, document analysis, and interviews offered a holistic view of the radiology department's dynamics. This in-depth understanding guided the discovery and evaluation of the RIS to enhance data accuracy,

automating workflows, and ultimately improve patient care within Zambia's public health sector.

3.3. FOSS Radiology Information System Discovery

Upon understanding the radiological workflows and challenges, we gathered requirements for identifying and evaluating a suitable FOSS RIS platform that would be used to automate radiological workflows at the UTHs in Zambia. A comparative analysis of different freely available FOSS RIS was done based on different metrics meeting the requirements. Two main radiology information systems were analysed in depth, OpenMRS Radiology Module and LibreHealth RIS.

3.3.1. Evaluation of OpenMRS Radiology Module

3.3.1.1. Functionality

The OpenMRS Radiology Information System module provides essential functionalities for managing radiology-related tasks, including patient scheduling, image storage, report generation, and billing. It offers a user-friendly interface to navigate and manage radiology workflows efficiently.

3.3.1.2. User Interface

The user interface of the OpenMRS Radiology Information System module is intuitive and straightforward, facilitating ease of use for healthcare professionals. Its simple design enhances user experience and minimises the learning curve.

3.3.1.3. Scalability

The OpenMRS Radiology Information System module demonstrates good scalability, catering to various healthcare facility sizes. It can adapt to the growing demands of radiology departments with increased patient volumes and data.

3.3.1.4. Customization

OpenMRS fosters a highly customizable environment, allowing healthcare facilities to tailor the Radiology Information System module to their specific needs. Customization options offer flexibility in adapting to unique workflows.

3.3.1.5. Performance

The performance of the OpenMRS Radiology Information System module is generally satisfactory. However, extensive data loads and simultaneous users might affect performance in larger healthcare settings.

3.3.1.6. Security

The OpenMRS Radiology Information System module prioritises data security through role-based access controls and encryption mechanisms. It maintains compliance with healthcare data protection standards.

3.3.1.7. Interoperability

OpenMRS promotes interoperability with other healthcare systems, enabling seamless data exchange and integration with Electronic Health Records (EHRs) and Picture Archiving and Communication Systems (PACS).

3.3.1.8. Support

The OpenMRS community offers active and helpful support to users through forums, documentation, and mailing lists. Users can seek assistance from a diverse and knowledgeable community of developers and healthcare professionals.

3.3.1.9. Documentation

Comprehensive documentation is available for the OpenMRS Radiology Information System module, providing valuable resources for implementation, customization, and troubleshooting.

3.3.2. Evaluation of LibreHealth RIS

3.3.2.1. Functionality

LibreHealth RIS offers a comprehensive set of functionalities, covering patient scheduling, image storage, reporting, and billing. It provides robust tools to automate radiology workflows efficiently.

3.3.2.2. User Interface

LibreHealth RIS boasts an intuitive and modern user interface, making it user-friendly for healthcare professionals. The interface design enhances user experience and ease of navigation.

3.3.2.3. Scalability

LibreHealth RIS demonstrates good scalability, accommodating the needs of various healthcare facilities. It can efficiently handle increased patient loads and radiology data volumes.

3.3.2.4. Customization

LibreHealth RIS allows a high degree of customization, empowering healthcare facilities to adapt the system to their specific requirements and workflows.

3.3.2.5. Performance

LibreHealth RIS exhibits solid performance, ensuring responsive and efficient operation even during peak usage periods.

3.3.2.6. Security

LibreHealth RIS prioritises data security, implementing measures such as role-based access controls and data encryption to safeguard patient information.

3.3.2.7. Interoperability

LibreHealth RIS supports interoperability with other healthcare systems, facilitating seamless data exchange with Electronic Health Records (EHRs) and Picture Archiving and Communication Systems (PACS).

3.3.2.8. Support

The LibreHealth community provides active support to users, offering assistance through forums, mailing lists, and community-driven resources.

3.3.2.9. Documentation

Comprehensive documentation for LibreHealth RIS is readily available, offering valuable resources for system implementation, configuration, and troubleshooting.

3.3.3. Comparison of OpenMRS Module and LibreHealth RIS

Below includes a feature matrix comparing OpenMRS Module and LibreHealth RIS.

Table 1: Feature Matrix

Metrics	OpenMRS	LibreHealth
Base Programming language	JAVA	PHP
Extensibility	HIGH	HIGH
Web Application Server	Jetty, GlassFish, WildFly, JBoss	Tomcat, GlassFish, WildFly, JBoss
API Support	RESTful	RESTful
Adoption/Use	HIGH	MEDIUM
Free/Community	YES	YES
Platform Scalability	HIGH	HIGH
Functionality Metrics		
Patient Registration	YES	YES
Report Creation	YES	YES
Communication between Radiologists and Physician (Chat Box)	NO	NO

3.3.4. Selection of FOSS Radiology Information System

Upon analysing and evaluating the different features of both OpenMRS version 2.7.8 with Radiology Module and LibreHealth RIS. We decided to settle for OpenMRS Radiology Module. This is because it is the mother from which LibreHealth RIS was developed and thus offers a wider community supporting its development and maintenance which is crucial for ensuring that the system to be adopted at the UTHs is one which is ongoing and will continue to receive updates and support in the future.

3.3.5. Usability Testing of FOSS Radiology Information System

Usability testing was a crucial step for the comprehensive evaluation of the OpenMRS Radiology Information System module; we focused on the features of Patient Registration

and Modality Request Scan as these proved to be the most needed in the steps of automating and automating the radiological workflows at the UTHs. Another vital feature that needed to be tested in terms of usability was Reporting on interpreted medical images. However, this was not done due to missing components of the OpenMRS RIS, which we foresee to be implemented in the future releases.

3.3.5.1. Data Analysis

To measure "usability" or "ease of use" of the OpenMRS RIS, we used the System Usability Scale (SUS) [13] shown in figure… . It is a 10-item questionnaire with 5 response options for each item, ranging from Strongly agree to Strongly disagree. The SUS questionnaire is based on the following usability dimensions:

- **Learnability:** How easy is it to learn how to use the system?
- **Efficiency:** How quickly can tasks be completed using the system?
- **Memorability:** How easy is it to remember how to use the system after a period of time?
- **Errors:** How many errors do users make when using the system?
- **Satisfaction:** How satisfied are users with the system overall?

3.3.5.1.1. Interpreting Scores

The participant's scores for each question was converted to a new number, added together and then multiplied by 2.5 to convert the original scores of 0-40 to 0-100. Though the scores showed a range from 0-100, these were not percentages and thus were to be considered only in terms of their percentile ranking. Interpretation of the Percentile ranking was evaluated as show below:

Table 2: SUS Score Grading

SUS Score	Grade	Adjectival Rating
> 80.3	A	Excellent
68 - 80.3	B	Good
68	C	Okay

51 - 68	D	Awful
<51	F	Poor

4. Results and Discussion

4.1. Workflows in the Radiology Department

Referring physicians are the primary care doctors and specialists, who order imaging exams for their patients. They play an important role in the radiology workflow, as they are responsible for determining the need for an imaging exam. Referring physicians will consider the patient's symptoms, medical history, and physical exam findings to determine if an imaging exam is necessary. Selecting the appropriate imaging exam, referring physicians will select the type of imaging exam that is most likely to provide the information needed to diagnose the patient's condition thereby communicating with the radiology department through a request form, referring physicians will provide the radiologist with any relevant information about the patient's case, such as their symptoms, medical history, and any medications they are taking.

Before the actual filming of the image, the patient must go through either the cashier or NHIMA. These cadres play an important role in ensuring that patients receive the care they need. They are responsible for verifying patients' insurance information and collecting any copays or deductibles that are due. Additionally, these cadres play an important role in ensuring that patients receive the care they need. This helps to ensure that the radiology department is able to operate efficiently and provide high-quality care to all patients, thereby playing a vital role in financial responsibilities and customer service.

Another cadre who plays an important role is the Clerk, they will check in the patients and collect any demographic information that is needed, such as the patient's name, address, and date of birth as well as the type of modality scan. On the other hand, they schedule the exam. The clerk will schedule the patient's exam for a convenient time and provide the patient with any necessary instructions for preparing the patient for the examination and what room the modality scan is to be taken. Once the patient is ready for their exam, the clerk will escort them to the appropriate modality room. This helps to ensure that the patient gets to the right place for their exam and that they are able to find the room without any difficulty.

Radiographers play a vital role in the healthcare system, providing essential imaging services to patients of all ages. They are highly trained professionals who use their knowledge and skills to produce high-quality images that help physicians diagnose and treat diseases and injuries. Once the patient is prepared, the radiographer will perform the scan. This involves

operating the imaging machine and acquiring the necessary images. The radiographer may need to adjust the patient's position or take multiple images to obtain the best results. After the scan is complete, the radiographer will review the images to ensure that they are of good quality. This may involve checking the images for sharpness and contrast. If the images are not of good quality, the radiographer may need to repeat the scan. Once the radiographer is satisfied with the images, they will release the patient. The radiographer may provide the patient with instructions for follow-up care or may simply tell the patient that they will hear from their radiology department through the clerk after some time.

Lastly but not least, Radiologists play a vital role in the radiology department, they use their expertise in imaging science to interpret a wide range of medical images, including X-rays, CT scans, MRI scans, and ultrasound images. By interpreting these images, radiologists can identify diseases and injuries that would otherwise be difficult or impossible to diagnose. They are also responsible for communicating their findings to the patient's referring physician and based on their findings, they may recommend specific treatments to the patient's referring physician and this may include medications, surgery, or other intervention. This communication is done through a report and it is essential for ensuring that patients receive the best possible care. On the other hand, radiologists work tirelessly to provide accurate and timely diagnoses for patients, and they play a critical role in developing treatment plans. Without radiologists, many diseases and injuries would go undiagnosed, and patients would not receive the treatment they need.

4.2. Challenges with Radiological Workflows

4.2.1. Cashiers

Following the observation exercise that was carried out, these are the challenges that were observed for cashiers in the Radiology department at the University Teaching Hospitals:

The recording of payments to the cashiers for medical imaging was manual (i.e. pen and paper), which was time-consuming and prone to inconsistencies.
After document analysis was conducted, the following challenges were found:

- Since the recording of payment transactions was manual (pen and paper), it was prone to errors that were caused by human error or refunds that needed to be made.

Finally, when the cashiers were interviewed, the following are the challenges they said they faced:

- Lack of a systematic payment processing system, resulting in cumbersome paperwork.
- Manual balancing of payment books and tedious submission of documents from office to office.

4.2.2. NHIMA

Relatively few challenges were observed for NHIMA officers, as they were already using a digitised payment system.

Upon interviewing the NHIMA officers, they put out the following challenges they faced in their line of work:

- Lack of integration of the NHIMA digitised system with a Radiology Information System, hindering efficient payment processing.
- Poor internet connection also posed a challenge when processing payments for patients.

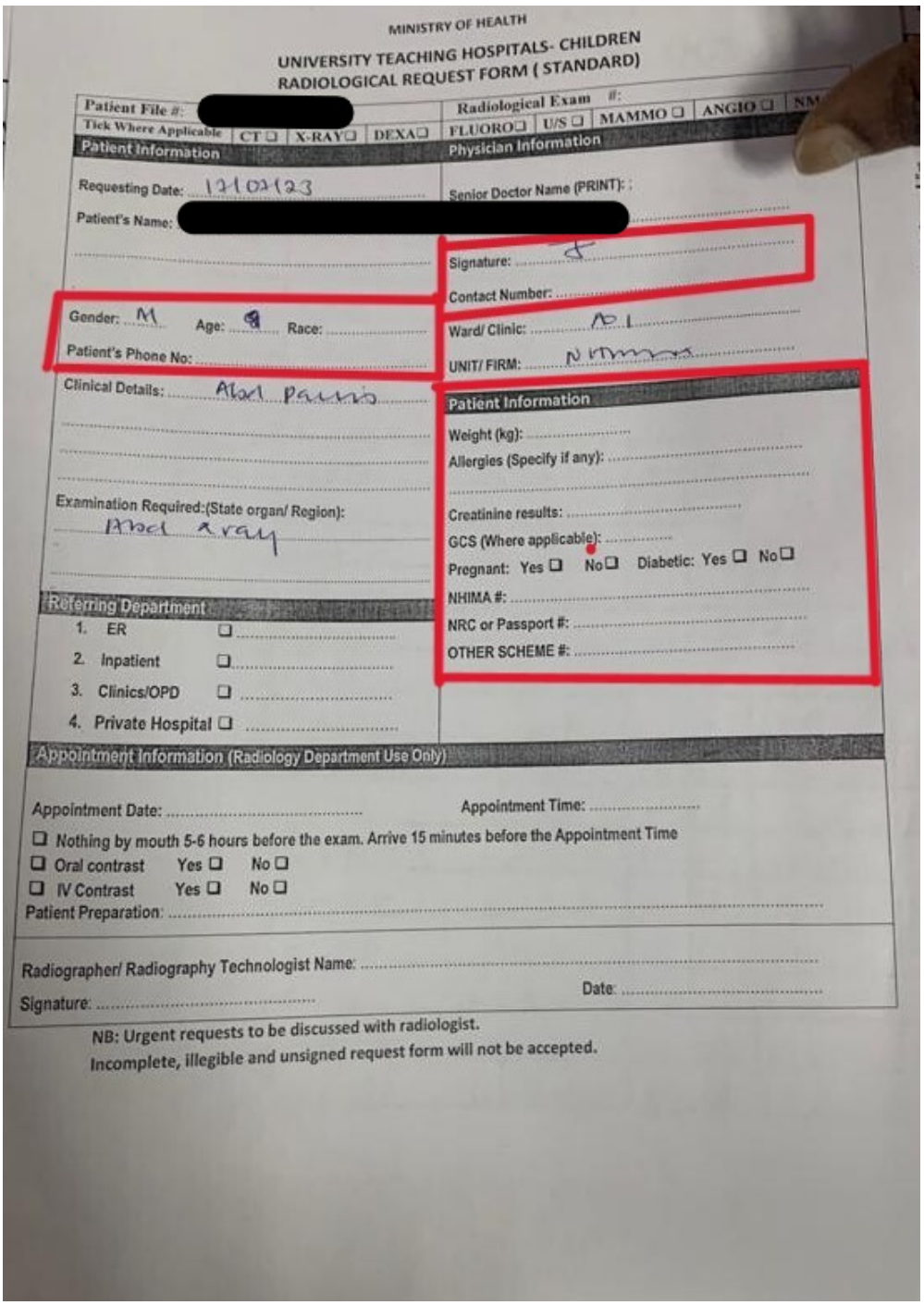
4.2.3. Clerks

The data entry clerks who were observed during the observation exercise faced the following challenges:

- Incomplete patient details on the request form from the referring physician. This made it difficult for the clerk to correctly register the patient.
- The registration process by the clerks was manual (i.e. pen and paper), which was time-consuming, creating patient queues.

Document analysis revealed additional challenges:

The request forms from the referring physicians that the patients give the data entry clerks at the reception of the radiology department of the UTHs had incomplete information about the patients. This made the registration of patients difficult. Figure 1 below illustrates this.



MINISTRY OF HEALTH

UNIVERSITY TEACHING HOSPITALS- CHILDREN

RADIOLOGICAL REQUEST FORM (STANDARD)

Patient File #: [redacted]

Radiological Exam #:

Tick Where Applicable | CT ☐ | X-RAY ☐ | DEXA ☐ | FLUORO ☐ | U/S ☐ | MAMMO ☐ | ANGIO ☐

Patient Information

Requesting Date: 12/02/23

Patient's Name: [redacted]

Gender: M Age: 9 Race:

Patient's Phone No:

Clinical Details: Abd Pains

Examination Required:(State organ/ Region):

Abd xray

Referring Department

1. ER ☐
2. Inpatient ☐
3. Clinics/OPD ☐
4. Private Hospital ☐

Physician Information

Senior Doctor Name (PRINT):

Signature:

Contact Number:

Ward/ Clinic: A&E

UNIT/ FIRM: Nrmms

Patient Information

Weight (kg):

Allergies (Specify if any):

Creatinine results:

GCS (Where applicable):

Pregnant: Yes ☐ No ☐ Diabetic: Yes ☐ No ☐

NHIMA #:

NRC or Passport #:

OTHER SCHEME #:

Appointment Information (Radiology Department Use Only)

Appointment Date: Appointment Time:

☐ Nothing by mouth 5-6 hours before the exam. Arrive 15 minutes before the Appointment Time

☐ Oral contrast Yes ☐ No ☐

☐ IV Contrast Yes ☐ No ☐

Patient Preparation:

Radiographer/ Radiography Technologist Name:

Signature: Date:

NB: Urgent requests to be discussed with radiologist.

Incomplete, illegible and unsigned request form will not be accepted.

Figure 1: Radiological request form

The books where patient details were recorded had inconsistent and wrong information recorded in the columns. The following images illustrate the following; inconsistent entry of data in the various columns, information entered in the wrong columns, incomplete

information leaving some data fields empty. All this has been highlighted by the red outlines in figure 2 below.

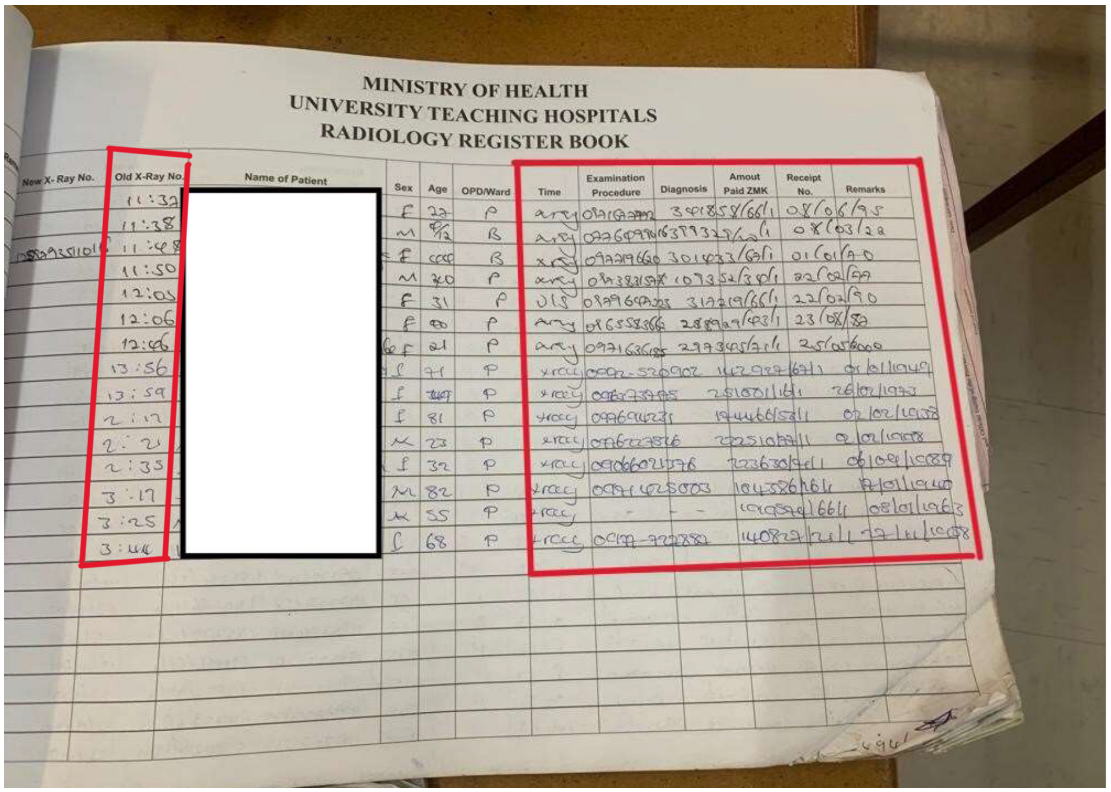


Figure 2: Clerk's registry

Finally, the interviews with clerks uncovered the following challenges:

- The manual process of registration using pen and paper proved to be cumbersome. This led to human errors.
- Apart from being prone to human errors, the manual process of using pen and paper was time consuming, leading to the formation of long patient queues at the registration desk in the radiology department.
- Another challenge the clerks discussed during the interviews was an issue with communication. They had to move up and down to find out from the radiologists if reporting results for patients were ready.

- Lastly but not least, another challenge that the clerks experienced was to do with tracing and disseminating patient results. Since the imaging results are brought back to the reception desk, the data clerks are responsible for giving the results back to the patients. However, since the results are given to the patients physically, the clerks have to trace the results from the batches they receive.

4.2.4. Radiographers

During the observations that were carried out, the following challenges were observed for radiographers in the Radiology department at the University Teaching Hospitals in Lusaka, Zambia:

- Some patients who went to the imaging room had inconsistent or incomplete details on their request forms, making it difficult for the radiographers to capture the patient details in their registration books (pen and paper) and imaging modality machines.
- Medical images that were captured were stored on cassettes and optical disks. When the images were captured, some patients forgot to collect their optical disks containing their medical images.

Document analysis that were conducted revealed the following challenges:

The patient details recorded in the books were inconsistent and incomplete. The images illustrate this by showing incomplete information with empty data fields. These errors are highlighted by the red outlines in figure 3 and figure 4 below.

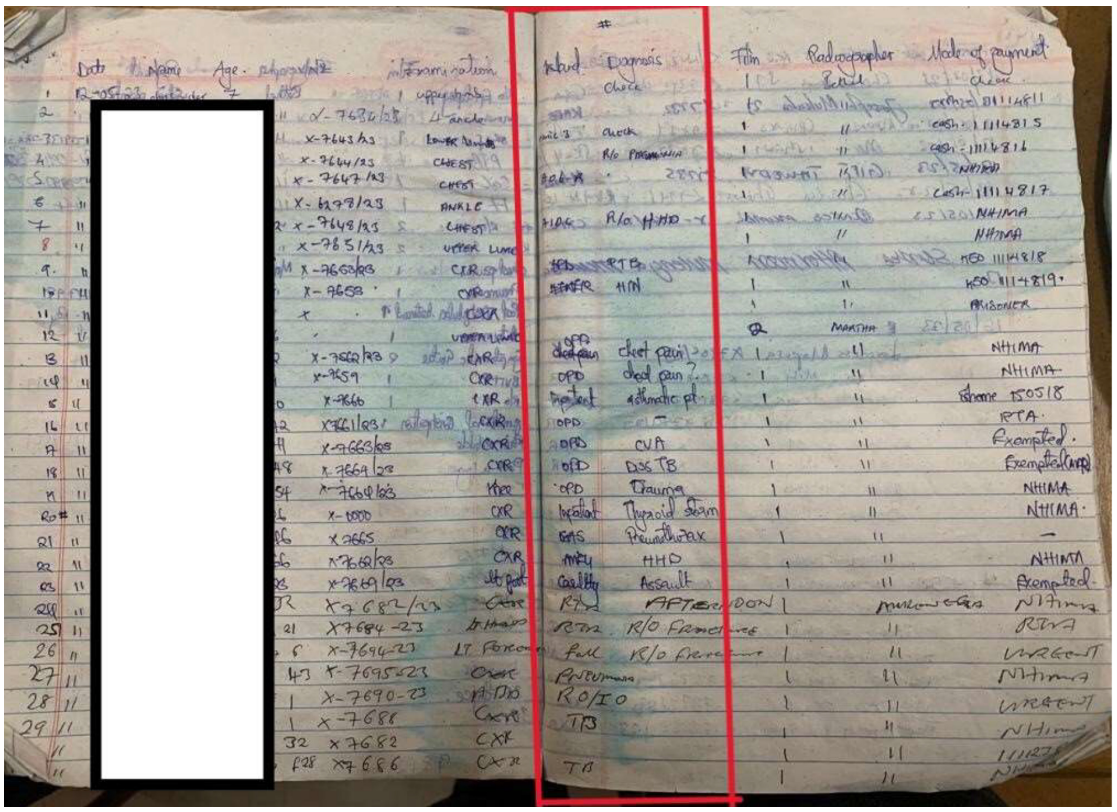


Figure 3: Radiographer's registry

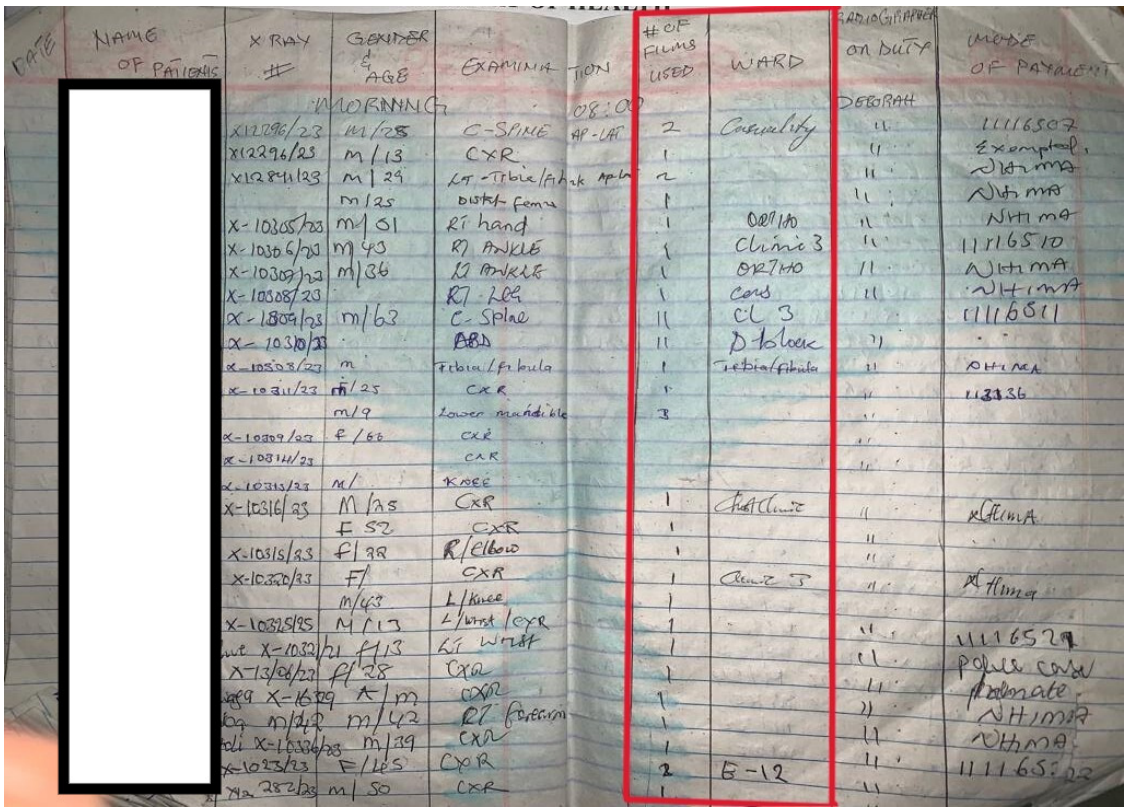


Figure 4: Radiographer's registry

Finally when interviews were conducted with the radiographers, these are the following challenges that they said to have experienced:

- Communication was an issue in instances where the radiographers required more clarity on exactly which part of the patient's body needed capturing. Radiographers were forced to improvise by asking the patient to capture the medical image and send it to the physician for confirmation. This made this method of doing things susceptible to issues concerning privacy.
- Another challenge that the radiographers in the radiology department faced was having to manually record (pen and paper) patient details before their image was captured. This proved to be time consuming and redundant because the patient's details were already captured at the reception by the data entry clerk.
- An additional challenge that the radiographers faced was missing information on the request forms. This would present another challenge because the patients' biometric

information was required by the radiographers to tune their image modality machines for effectiveness and safety.

- Another challenge that the radiographers faced was burning of CDs. Seeing that the results of the images were stored and disseminated on physical CDs, a lot of time was taken. This was further exacerbated by the fact that the same modality machine used for capturing medical images was used for burning the images on the CDs. And that could not be done simultaneously but could only be done one at a time. Therefore the time taken for one patient to have their image captured and burnt on the CD was a lot.
- Finally, another challenge faced was the loss of some medical images captured. Furthermore, some patients forgot to collect their CDs meaning they would not have their images reported on by a radiologist.

4.2.5. Radiologists

The following challenges were observed for radiologists in the Radiology department at the University Teaching Hospitals:

- Shortage of radiologists serving a large population of patients, which consequently made image report results take longer.
- During the interviews with the radiologists, the following challenges were discussed:
- The quality of images burnt on the CDs or cassettes was degraded making it difficult for accurate reporting.
- Seeing that there were very few radiologists reporting a multitude of images, made the process take longer.

4.3. Evaluation of FOSS RIS platform

4.3.1. OpenMRS Evaluation

After understanding the radiological workflows and challenges at the University Teaching Hospitals the FOSS OpenMRS was deployed with the Radiology Module and we evaluated usability or ease of use, focusing on two main features i.e patient registration and requesting for a modality scan feature. To test for ease of use for these two main features, 20 students from the University of Zambia were sampled out based on random sampling. These came from different fields and years of study.

Below are images illustrating the various parts of the system, from logging in, patient registration to requesting for a modality scan.

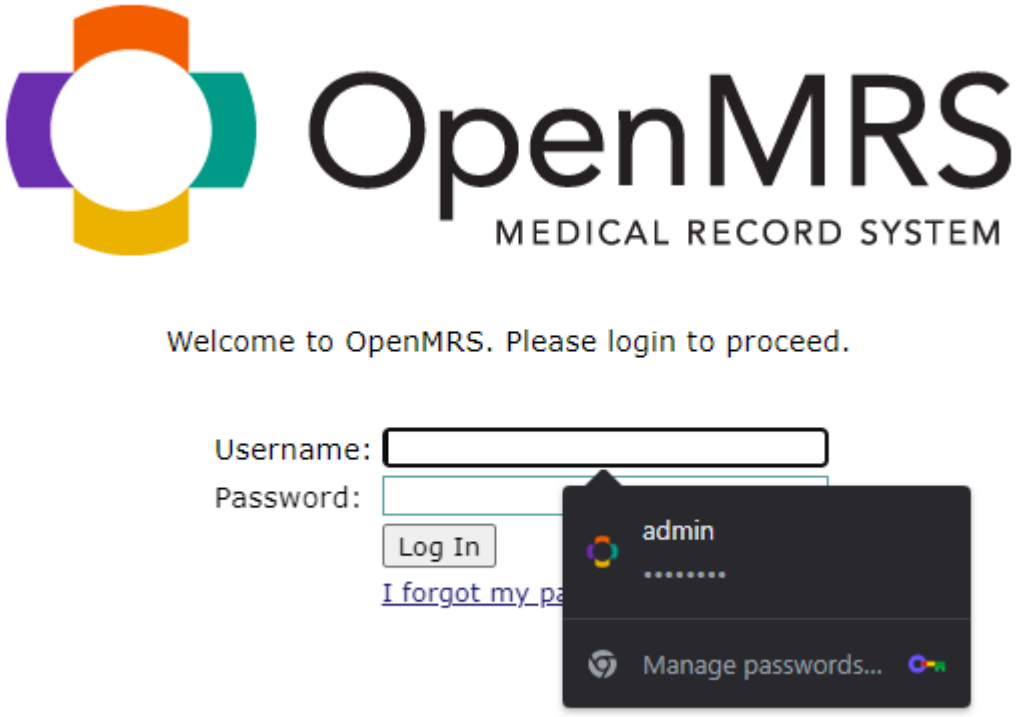


Figure 5: OpenMRS Logging Interface

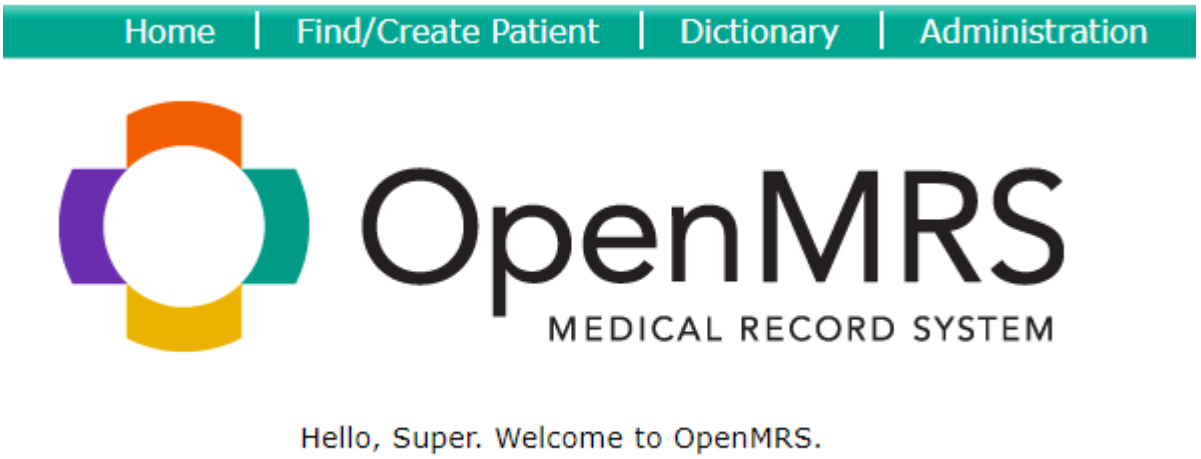


Figure 6: OpenMRS Home Screen Interface

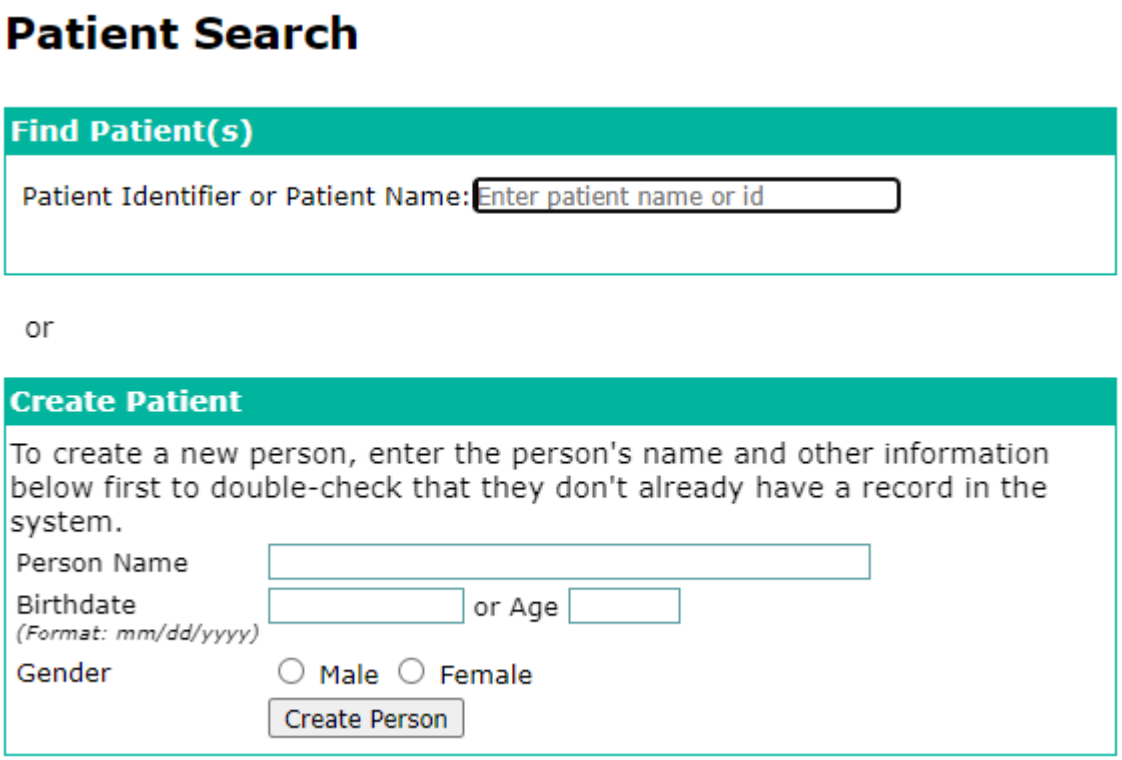


Figure 7: OpenMRS Patient Search and Creation Interface

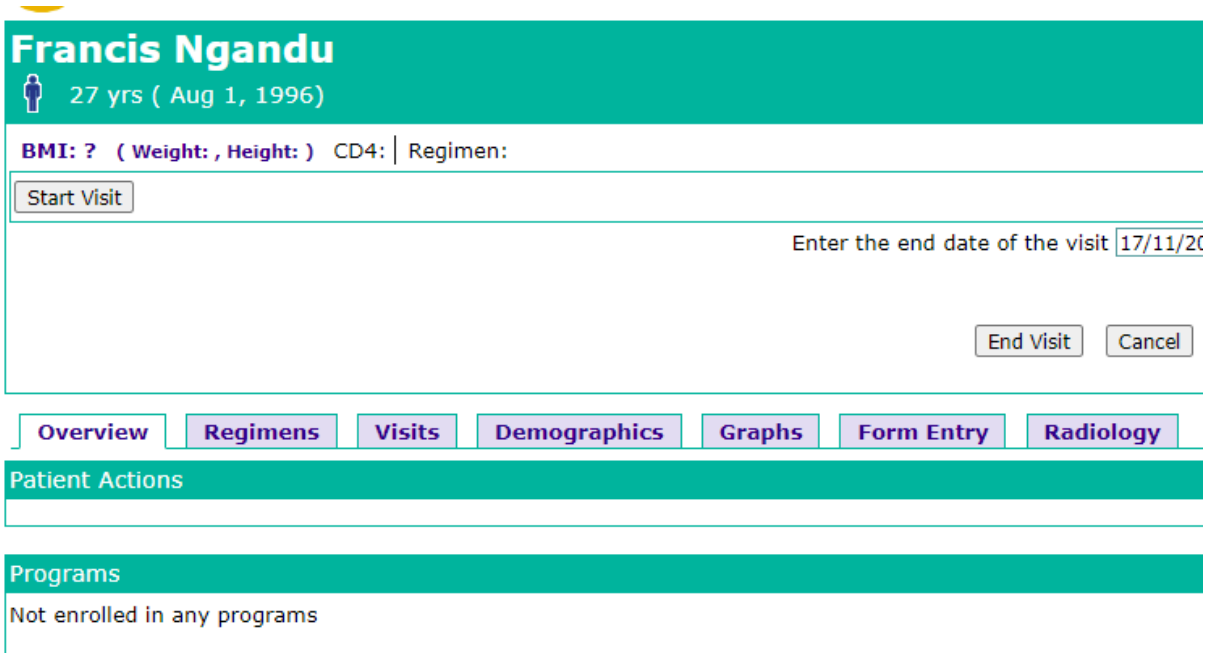


Figure 8: OpenMRS Patient Info Dashboard with Radiology Tab

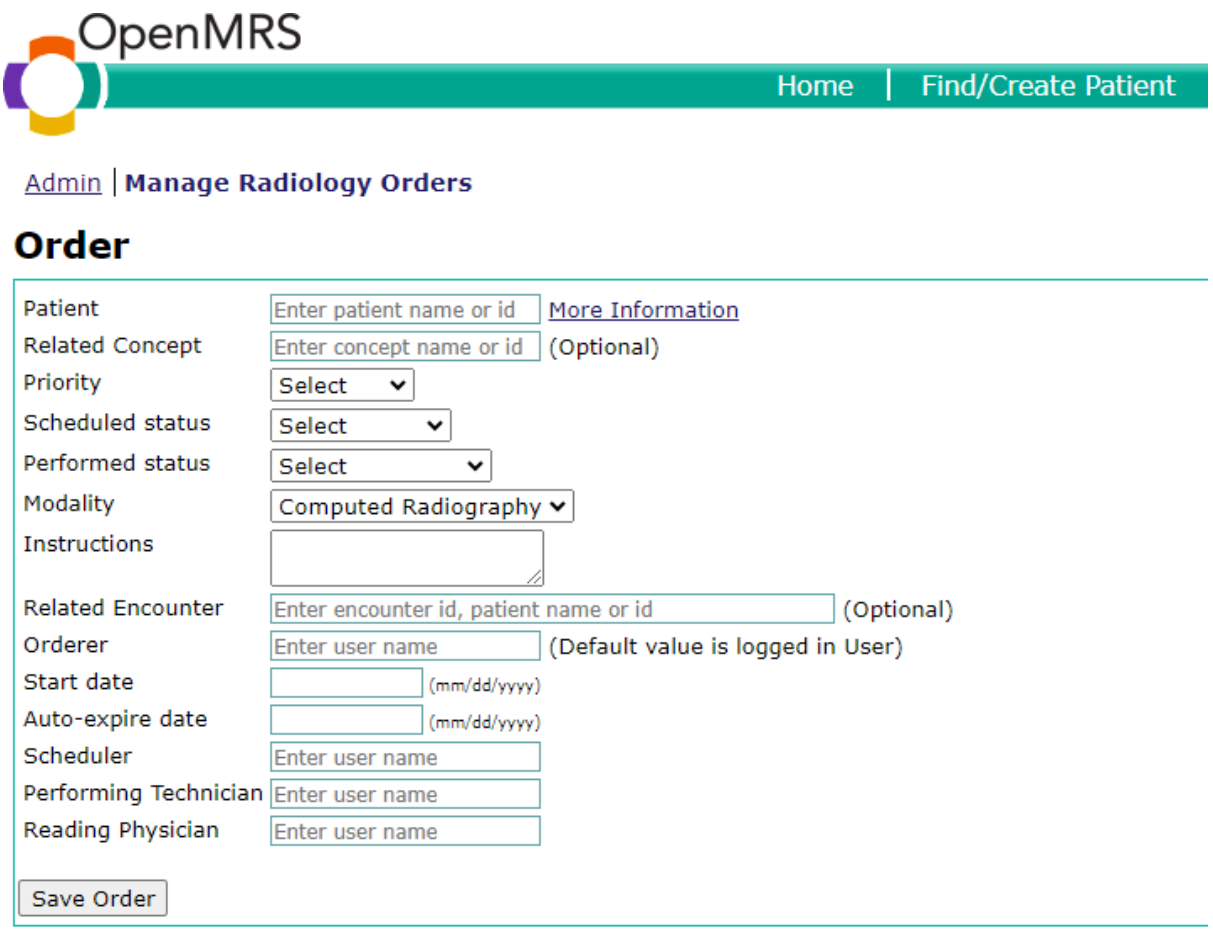
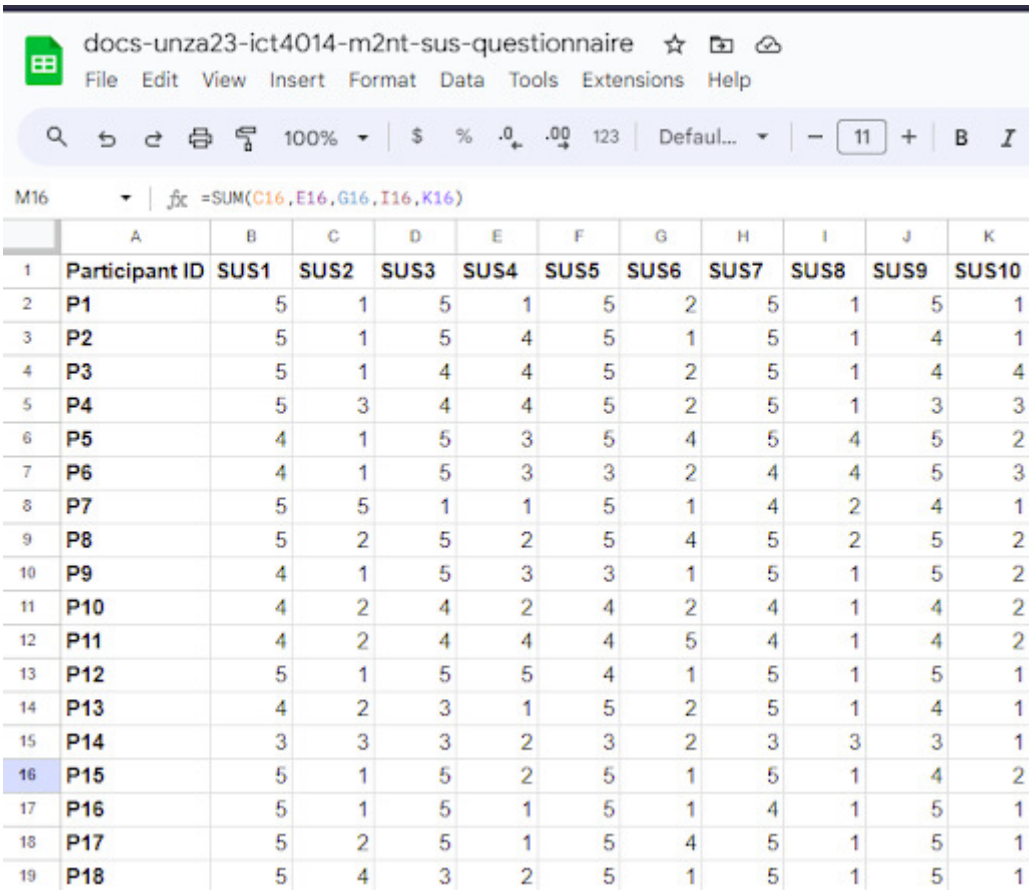


Figure 9: OpenMRS Modality Request Interface

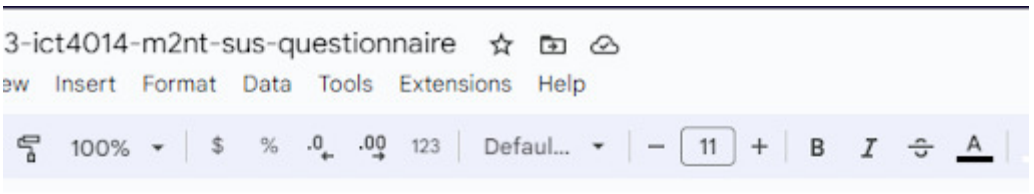
4.4. Data Analysis

After testing the system, the participants were tasked to complete the SUS questionnaire. The SUS score grade for the overall usability of the system came out at 79% which is between 68% - 80.3% giving an adjectival rating of Good thereby recommending the adoption of the system.



	A	B	C	D	E	F	G	H	I	J	K
1	**Participant ID**	**SUS1**	**SUS2**	**SUS3**	**SUS4**	**SUS5**	**SUS6**	**SUS7**	**SUS8**	**SUS9**	**SUS10**
2	**P1**	5	1	5	1	5	2	5	1	5	1
3	**P2**	5	1	5	4	5	1	5	1	4	1
4	**P3**	5	1	4	4	5	2	5	1	4	4
5	**P4**	5	3	4	4	5	2	5	1	3	3
6	**P5**	4	1	5	3	5	4	5	4	5	2
7	**P6**	4	1	5	3	3	2	4	4	5	3
8	**P7**	5	5	1	1	5	1	4	2	4	1
9	**P8**	5	2	5	2	5	4	5	2	5	2
10	**P9**	4	1	5	3	3	1	5	1	5	2
11	**P10**	4	2	4	2	4	2	4	1	4	2
12	**P11**	4	2	4	4	4	5	4	1	4	2
13	**P12**	5	1	5	5	4	1	5	1	5	1
14	**P13**	4	2	3	1	5	2	5	1	4	1
15	**P14**	3	3	3	2	3	2	3	3	3	1
16	**P15**	5	1	5	2	5	1	5	1	4	2
17	**P16**	5	1	5	1	5	1	4	1	5	1
18	**P17**	5	2	5	1	5	4	5	1	5	1
19	**P18**	5	4	3	2	5	1	5	1	5	1

Figure 10: Showcases sample data collected from usability testing.



L	M	N	O	P	Q
X(Sum of Odd)	Y(Sum of Even)	X0 (X - 5)	Y0 (25 - Y)	SUS (X0 + Y0)*2.5	Grade
25	6	20	19	97.5	A
24	8	19	17	90	A
23	12	18	13	77.5	B
22	13	17	12	72.5	B
24	14	19	11	75	B
21	13	16	12	70	B
19	10	14	15	72.5	B
25	12	20	13	82.5	A
22	8	17	17	85	A
20	9	15	16	77.5	B
20	14	15	11	65	D
24	9	19	16	87.5	A
21	7	16	18	85	A
15	11	10	14	60	D
24	7	19	18	92.5	A
24	5	19	20	97.5	A
25	9	20	16	90	A

Figure 11: Showcases how sample data collected from usability testing was being processed.

The SUS score grade for the overall usability of the system came out at 79% which is between 68% - 80.3% giving an adjectival rating of Good thereby recommending the adoption of the system.

Descriptive Stats	SUS Scores	SUS Mean Score Grade
Mean	79	B
Standard Deviation	13.06360956	
Min	45	
Max	97.5	

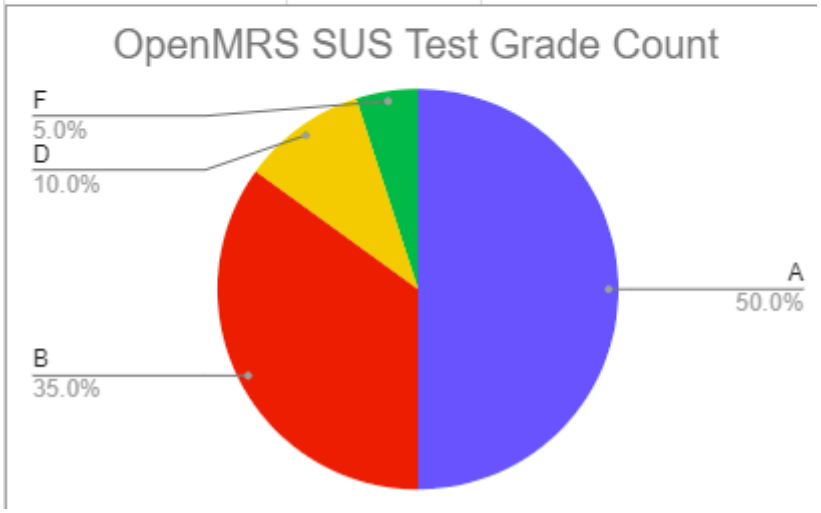


Figure 12: Showcases descriptive statistics of the results from usability testing

5. Conclusion

In conclusion, our research focused on addressing the challenges faced by the public health sector in Zambia, particularly at the UTHs, in managing and radiological tasks in the radiology department. The shortage of qualified radiologists, combined with manual and paper-based workflows, had led to delays in medical imaging services, diagnoses, and patient care. Our study aimed to explore the feasibility of adopting a FOSS RIS platform to automate radiological workflows.

Through a comprehensive investigation, we identified the primary workflows and challenges of the radiology department at the UTHs. The shortage of radiologists, coupled with an increasing volume of imaging data, necessitated a solution to enhance efficiency and reduce turnaround time. Our specific objectives included understanding current workflows, identifying a suitable FOSS RIS platform, and evaluating its usability in automating radiological tasks.

Our study's rationale was grounded in the need to improve patient care by reducing delays in interpreting and reporting medical images. We considered factors such as compatibility, interoperability, extensibility, and community support in the evaluation of FOSS RIS platforms. Collaboration with the radiology department staff ensured that the selected system met their specific needs, fostering a user-centric approach to implementation.

The results of our evaluation demonstrated the potential of adopting a FOSS RIS platform to automate radiological workflows at UTHs. The system's usability indicated the potential for shifting from manual to automated workflows. As we move forward, the integration of FOSS solutions in medical imaging workflows could serve as a model for addressing similar challenges in other developing regions, contributing to the global advancement of healthcare technologies.

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7. Appendix A: Interview Questions

Table A1: Questions for Referring Physician

Areas of Interest	Question	Probe
Roles and Responsibilities	● Can you describe your role as a referring physician and how you interact with the Radiology department? ● How would you describe the referral process to the radiology department? ● What are the biggest challenges you face in referring patients for imaging studies? ● How frequently do you order radiological tests or studies for your patients, and what types of exams are most common in your practice?	● How do you communicate with the radiology team about your patients' needs?
Perception of current Radiological workflows	● From your perspective, how do you perceive the current radiological workflows in terms of efficiency and effectiveness in supporting patient care?	
Pain Point in existing Radiological Workflows	● What challenges do you face when requesting for radiological investigations ● What challenges do you face regarding access to radiological reports ● Do you think implementation of a RIS would assist to mitigate these challenges ● What measures would you suggest to help overcome or minimise the said challenges	
Suggestions for Improvement	● What areas of the workflow do you think could be improved? ● How do you think the implementation of an interoperable RIS platform can potentially address the challenges you mentioned?	

Table A2: Questions for Clerk

Areas of Interest	Question	Probe
Roles and Responsibilities	● Can you describe your role and responsibilities in the Radiology department, particularly regarding patient registration and data entry? ● What tools or systems do you currently use for patient registration and data entry tasks? ● How does your role interact with other staff members or departments within the Radiology department? ● How do you handle imaging requests, and result dissemination?	
Perception of current Radiological workflows	● What do you think about the efficiency and effectiveness of the process of patient registration, requesting for an examination and getting the result and/or report as was requested? ● Are there any specific tasks or steps in the workflow that you find particularly time-consuming or inefficient?	
Pain Points in existing Radiological Workflows	● What are the main challenges that you face when processing radiological request forms and patient/client registration ● Are there any specific pain points or obstacles that hinder your ability to perform your tasks efficiently ● How can these challenges be reduced or eliminated	

Suggestions for Improvement	● Based on your experience, do you have any suggestions for improving the current radiological workflows, particularly in your area of responsibility? ● How do you envision the ideal Radiology Information System that could address the challenges and improve the workflows in the department? ● Are there new features or functionality that you would like to see in a new Radiology Information System?	

Table A3: Questions for Cashier

Areas of Interest	Question	Probe
Roles and Responsibilities	● Can you please describe your day-to-day responsibilities as a cashier in the radiology department? ● How do you process payments efficiently and accurately?	
Payment/Collection Process	● Could you walk us through the payment collection process, from the moment a patient arrives for an imaging service to the completion of the transaction? ● Are there specific payment methods you accept (e.g., cash, credit cards, insurance billing), and do you face any challenges with certain payment methods? ● How do you reconcile your payments at the end of the day? ● How do you handle patients with questions or concerns about their bills or insurance coverage? ● How do you handle situations where patients may have difficulty making payments or need financial assistance? ● How do you handle refunds?	

Perception of current Radiological workflows	• What tools or software systems do you use for processing payments and managing financial records? • How would you describe the current radiological workflows in terms of efficiency and effectiveness?	
Pain Points in existing Radiological Workflows	• What challenges do you face when processing receipts for payments for radiological examinations • Would incorporation of billing and receipt generation by a platform such as RIS help to reduce the challenges you have identified, and how	
Suggestions for Improvement	• What would make your job easier and more efficient? • What new features or functionality would you like to see in a new Radiology Information System?	

Table A4: Questions for NHIMA

Areas of Interest	Question	Probe
Roles and Responsibilities	• Can you please describe your day-to-day responsibilities as a NHIMA payment officer? • What are the different types of payments that you handle? • Which roles in the Radiology department are involved in processing NIHMA patients/clients?	
Payment/Collection Process	• Could you walk us through the payment process, from the moment a patient arrives for an imaging service to the completion of the transaction? • How are the service charges associated with clients' NHIMA accounts?	
Perception of current Radiological	• How would you describe the current radiological workflows specifically your role in terms of efficiency and	

workflows	effectiveness? ● How long does it take to process a NHIMA request? ● What forms are used to process NHIMA requests? ● What information is captured? ● How is the NIHMA authorisation process linked to the Radiological services? ● What tools or software systems do you use for processing payments and managing financial records?	
Pain Points in existing Radiological Workflows	● What are the biggest challenges that you face in processing payments for patients on the NHIMA health insurance scheme?	
Suggestions for Improvement	● Can you suggest any ways to improve the efficiency and effectiveness of the current radiological workflows? ● What new features or functionality would you like to see in a new Radiology Information System that would make your job easier and more efficient?	

Table A5: Questions for Radiographer

Areas of Interest	**Question**	**Probe**
Roles and Responsibilities	● What role do you play in the overall radiology department? ● How do you handle imaging requests, image acquisition, and result dissemination? ● Are there any specific equipment or software you regularly use as part of your job?	
Perception of current Radiological workflows	● How would you rate the efficiency and effectiveness of the current radiological workflows at UTH? ● What are the biggest strengths and weaknesses of the current system?	

	● Are there any areas in the current workflow that you find to be inefficient or time-consuming?	
Pain Point in existing Radiological Workflows	● What challenges do you face when reading radiological request forms in the form that they are currently presented ● Are there any specific tasks or steps in the workflow that you find particularly time-consuming or inefficient? ● Are there any challenges associated with entering patient details when performing radiologic examinations?	
Suggestions for Improvement	● Do you have any suggestions or ideas for improving the current radiological workflows? ● How do you think a new RIS could help to improve the efficiency and effectiveness of the radiology department? ● What features would you like to see in a new Radiology Information System?	

Table A6: Questions for Radiologist

Areas of Interest	Question	Probe
Roles and Responsibilities	● Can you describe your role and responsibilities as a radiologist in the Radiology department? ● What are the typical tasks and procedures you perform on a day-to-day basis? ● How do you handle imaging requests, interpretation, reporting, and result dissemination?	
Perception of current Radiological workflows	● How do you handle imaging requests, interpretation, reporting, and result dissemination? ● What do you think about the efficiency and effectiveness of the process of requesting an examination and getting the result and/or report as was requested? ● How would you rate the efficiency and	● What are the biggest strengths and weaknesses of the current system?

	effectiveness of the current radiological workflows at UTH?	
Pain Points in existing Radiological Workflows	● Can you identify any pain points in the existing radiological workflows that affect your work as a radiologist? ● What do you think are the challenges or pain points or bottlenecks in the process of requesting and getting an examination with the desired result done from the department? ● Have there been any instances where these challenges have impacted patient diagnosis or treatment plans?	● Are there any specific tasks or steps in the workflow that you find particularly time-consuming or inefficient?
Suggestions for Improvement	● Based on your experience, do you have any suggestions or ideas for improving the current radiological workflows, especially from a radiologist's perspective? ● How do you think a new RIS could help to improve the efficiency and effectiveness of the radiology department? ● Are there specific tools or technologies you believe would enhance your efficiency and accuracy in interpreting medical images?	

8. Appendix B: SUS Questionnaire

The SUS Questionnaire						
SUS ID	**Questions**	**Strongly disagree**				**Strongly agree**
1	I think that I would like to use this system frequently	☐	☐	☐	☐	☐
2	I found the system unnecessarily complex	☐	☐	☐	☐	☐
3	I thought the system was easy to use	☐	☐	☐	☐	☐
4	I think that I would need the support of a technical person to be able to use this system	☐	☐	☐	☐	☐
5	I found the various functions in this system were well integrated	☐	☐	☐	☐	☐
6	I thought there was too much inconsistency in this system	☐	☐	☐	☐	☐
7	I would imagine that most people would learn to use this system very quickly	☐	☐	☐	☐	☐
8	I found the system very cumbersome to use	☐	☐	☐	☐	☐
9	I felt very confident using the system	☐	☐	☐	☐	☐
10	I needed to learn a lot of things before I could get going with this system	☐	☐	☐	☐	☐

Figure B.1: SUS Questionnaire

9. Appendix C : Ethical Clearance Approval

UNIVERSITY OF ZAMBIA
BIOMEDICAL RESEARCH ETHICS COMMITTEE

Telephone: 260-1-256067
Telegrams: UNZA, LUSAKA
Telex: UNZALU ZA 44370
Fax: + 260-1-250753
Federal Assurance No. FWA00000338

Ridgeway Campus
P.O. Box 50110
Lusaka, Zambia
E-mail: unzarec@unza.zm
IRB00001131 of IORG0000774

11th May, 2023.

Ref. No. 2731-2022.

Dr. Ernest Obbie Zulu,
University Teaching Hospitals,
Adult Hospital Department of Radiology,
P/Bag RW 1X,
Ridgeway,
Lusaka.

Dear Dr. Zulu,

RE: APPLICATION FOR RENEWAL OF ETHICAL CLEARANCE APPROVAL: "ENTERPRISE MEDICAL IMAGING FOR STREAMLINED RADIOLOGICAL DIAGNOSIS IN ZAMBIAN PUBLIC HEALTH FACILITIES" (REF. NO. 2731-2022)

We acknowledge receipt of the request for renewal to the aforementioned study.

Renewal is hereby given for a period of one year from 5th May 2023 to 4th May 2024.

Yours sincerely,

Munsaka.

Sody Mweetwa Munsaka, BSc., MSc., PhD
CHAIRPERSON
Tel: +26099925304
E-Mail: s.munsaka@unza.zm

Figure C.1: UNZABREC Ethical Clearance Form

NATIONAL HEALTH RESEARCH AUTHORITY
Paediatric Centre of Excellence, University Teaching Hospital, P.O. Box 30075, LUSAKA
Chalala Office Lot No. 18961/M, Off Kasama Road, P.O. Box 30075, LUSAKA
Tell: +260211 250309 | Email: znhrasec@nhra.org.zm | www.nhra.org.zm

Ref No: NHRA000024/10/05/2022 **Date: 10th May, 2022**

The Principal Investigator,
Ernest Obbie Zulu,
University of Zambia
Lusaka, Zambia.

Dear Ernest Obbie Zulu,

Re: Request for Authority to Conduct Research

The National Health Research Authority is in receipt of your request for authority to conduct research titled **"Enterprise Medical Imaging for Streamlined Radiological Diagnosis in Zambian Public Health Facilities."**

I wish to inform you that following submission of your request to the Authority, our review of the same and in view of the ethical clearance, this study has been **approved** on condition that:

1. The relevant Provincial and District Medical Officers where the study is being conducted are fully appraised;
2. Progress updates are provided to NHRA quarterly from the date of commencement of the study;
3. The final study report is cleared by the NHRA before any publication or dissemination within or outside the country;
4. After clearance for publication or dissemination by the NHRA, the final study report is shared with all relevant Provincial and District Directors of Health where the study was being conducted, University leadership, and all key respondents.

Yours sincerely,

Prof. Godfrey Biemba
Director/CEO
National Health Research Authority

Figure C.2: NRHA Ethical Clearance Approval

All Correspondence should be addressed to the
Permanent Secretary
Telephone: +260 211 253040/5
Fax: +260 211 253344

REPUBLIC OF ZAMBIA
MINISTRY OF HEALTH

In reply please quote:
MOH/
No.....

NDEKE HOUSE
P. O. BOX 30205
LUSAKA

16th May, 2022

Obbie Zulu
LUSAKA

RE: REQUEST FOR AUTHORITY TO CONDUCT RESEARCH

Reference is made to your letter dated 25th April, 2022 in which you requested the Ministry, for permission to conduct a research titled "***Enterprise Medical Imaging for Streamlined Radiological Diagnosis in Zambia Public Health Facilities***". I wish to inform you that my office has no objection to this request provided that;

1. The relevant Institution Director where the study is being conducted are fully appraised;
2. The final study report is cleared by NHRA before any publication or dissemination within or outside the country; and
3. After clearance for publication or dissemination by NHZRA, the final study report is shared with the Ministry.

Kindly ensure minimum interruption in health service delivery to the selected health you will undertake your research.

By copy of this letter, the Provincial, District Health Offices and facilities are advised to allow you undertake the above mentioned research and provide you with the relevant support.

Yours faithfully

Prof. Lackson Kasonka
Permanent Secretary- Technical Services
MINISTRY OF HEALTH

Figure C.3: Ministry Of Health Ethical Clearance Form

REPUBLIC OF ZAMBIA
MINISTRY OF HEALTH

University Teaching Hospitals -Adult

Fax: +260 211 250305
e-mail: mduth@yahoo.com

P/Bag Rw 1X
Lusaka - Zambia
Tel: +260 211 253947 (Switch Board)
+260 211 251451

OFFICE OF THE SENIOR MEDICAL SUPERINTENDENT

Our Ref:

Your Ref:

5th September, 2022

Dr. Ernest Obbie Zulu
University of Zambia
Department of Library & Information Science
P O Box 50110
LUSAKA

Dear Dr. Zulu,

RE: REQUEST FOR AUTHORITY TO CONDUCT RESEARCH

The University Teaching Hospital – Adult is in receipt of your letter dated 5th September, 2022 in which you had requested to conduct a research titled ***"Enterprise Medical Imaging for Streamlined Radiological Diagnosis in Zambia Public Health Facilities" at the University Teaching Hospital."***

I wish to inform you that permission has been granted and you are advised to liaise with the Head of Department.

Yours faithfully,

Dr. Mwila Lupasha
Head Clinical Care
for/**Senior Medical Superintendent**
UNIVERSITY TEACHING HOSPITALS - ADULT

Figure C.4: UTH Ethical Clearance Form

Radiology Department
University Teaching Hospitals
Private Bag RW 1X
Ridgeway
Lusaka, Zambia, 10101

The Head Clinical Care (HCC)
University Teaching Hospitals
Private Bag RW 1X
Ridgeway
Lusaka, Zambia, 10101

Approved
5.09.2022

September 2, 2022

REF: REQUEST FOR ACCESS TO PATIENTS' OLD RADIOLOGY REPORTS AND IMAGES FOR THE PURPOSE OF SYSTEMATICALLY ORGANIZING THEM TO FACILITATE THEIR EFFICIENT STORAGE AND RETRIEVAL AS PART OF A PILOT RESEARCH PROJECT — ENTERPRISE MEDICAL IMAGING FOR STREAMLINED RADIOLOGICAL DIAGNOSIS IN ZAMBIAN PUBLIC HEALTH FACILITIES.

Dear Sir,

I am a fourth year Specialty Training Programme (STP) student in Radiology (ID number STPRAD 19010107) at the UTHs Adult hospital. I am collaborating with Dr. Lighton Phiri from the University of Zambia in conducting the pilot project mentioned above under the UNZA DRGS. We hereby request for access to patients' old radiology reports and images stored in the library/department at this hospital. The UTHs have been deliberately selected for piloting of this project, which was approved by UNZABREC and NHRA (References: UNZA-2731-2022 and NHRA000024/10/05/2022).

The accessed data (images and reports) will be kept confidential before, during and after the digitisation process and the final package shall be handed over to the Head of Department, Radiology.

I look forward to hearing from you.

Ernest Obbie Zulu, MBChB
Mobile: +26 097 7 199434; Email: obbiernest@gmail.com

Figure C.5: Head of Clinical Care Clearance Form