WEB-BASED PERSONAL DOSE MANAGEMENT SYSTEM FOR DATA RECORDING ON DOSIMETER USAGE: A CASE OF TANZANIA ATOMIC ENERGY COMMISSION

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A Project Report Submitted in Partial Fulfillment of the Requirements of the Award the Degree of Master of Science in Embedded and Mobile Systems of the Nelson Mandela African Institution of Science and Technology

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ABSTRACT

Modern technology drives the world, increasing performance while reducing labour and time expenses. Tanzania Atomic Energy Commission (TAEC) tracks employees' levels of exposure to radiation sources using dosimeters. According to legal compliance, workers wear dosimeters for three months and one month at the workplace. However, TAEC has problems in tracking, issuing, and returning dosimeters because the existing tracking is done manually. The study intended to develop a Personal Dose Management System (PDMS) that processes and manages the data collected by dosimeters for easy and accurate records. During the requirements elicitation process, the study looked at the existing system. PDMS' requirement gathering included document reviews, user interviews, and focused group discussions. Development and testing of the system were implemented by applying the evolutionary prototyping technique. The system provides a login interface for system administrators, radiation officers, and Occupational Exposed Workers. The PDMS grants TAEC Staff access to monitor individual exposed workers, prints individual and institutional reports and manages workers' information. The system reminds the users when to return dosimeters to TAEC, generates reports, and facilitates dispatching and receiving dosimeters effectively. PDMS increases efficiency and effectiveness while minimizing workload, paperwork, and inaccurate records. Although the existing systems are beneficial to their respective countries, they are designed based on the specific institution. The system developed simplifies the procedures for requesting dosimeters, reminding users when to return the dosimeter, and printing quarterly and annual reports for individuals and institutions. Therefore, based on the results obtained from the system, it is recommended to use the system to improve dosimeter data management at the institution.

DECLARATION

I, Angela Paul Mseke, do hereby declare to the Senate of the Nelson Mandela African Institution of Science and Technology that this project report is my original work and that it has neither been submitted nor being concurrently submitted for a degree award in any other institution.

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by The Nelson Mandela African Institution of Science and Technology, a project report titled " **Web-Based Personal Dose Management System for Data Recording on Dosimeter Usage: A Case of Tanzania Atomic Energy Commission"** in partial fulfillment of the requirements for the degree of Master of Science in Embedded and Mobile Systems of the Nelson Mandela African Institution of Science and Technology.

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DEDICATION

This project report is dedicated to my husband Charles, son Cuthbert, and my family, who have been extremely patient with me throughout the study.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS AND SYMBOLS

ALARA	As Low As Reasonably Achievable
CSS	Cascading Style Sheet
DMS	Dose Management System
DPRSN	Radiological Protection and Nuclear Safety Department
GUI	Graphical User Interface
HTML	Hyper Text Mark-up Language
IAEA	International Atomic Energy Agency
ICT	Information Communication Technology
IMS	Individual Monitoring for External Radiation Service
ITN	Nuclear and Technological Institute
NDR	National Dose Registry
OS	Operating System
PDMS	Personal Dose Management System
PHP	Hypertext Pre-processor
SQL	Structured Query Language
TAEC	Tanzania Atomic Energy Commission
TLD	Thermoluminescent Dosimeter
XAMPP	Cross platform, Apache server, My Structured Query Language, Perl and Hypertext Preprocessor

CHAPTER ONE

INTRODUCTION

1.1 Background of the Problem

Globally, there has been a noticeable shift in how information and communication technology (ICT) is used in various industries such as agriculture, banking, mining, transportation, and communication, to name a few. Furthermore, the ever-changing technologies brought by the internet have put a lot of pressure on many industries and individuals to access all online resources and stay current with modern technological developments (Torkayesh & Torkayesh, 2021).

The development of a Personal Dose Management System (PDMS) came to light since the Tanzania Atomic Energy Commission (TAEC) has been experiencing problems while collecting, processing, and managing the data obtained through dosimeters worn by workers in radioactive environments. The goal of monitoring each employee's radiation exposure level is to record the level of exposure of each worker who is exposed to radioactive sources. The objectives of reduce the likelihood of deterministic effects such as radiation-induced skin burns and acute radiation syndrome effects occurring and the probability of stochastic such as cancer induction and radiation-induced hereditary effects occurring by keeping the doses as low as reasonably achievable. For a variety of reasons, occupational radiation exposure levels are regularly monitored by the use of dosimeters. The primary reason is to regulate dose limits by routinely monitoring personal dosimetry, one of the most important approaches for attaining, demonstrating, and detecting new dangers due to unacceptable degrees of radiation exposure. It is also one of the key instruments for reaching and showing an adequate degree of radiation protection in the framework of the ALARA principle (Covens *et al.*, 2007).

The term "dosimetry" refers to the process of determining and measuring the amount or dosage of radiation absorbed by a substance or biological creature using a dosimeter. Dosimetry is routinely used to keep track of people who work with radioactive materials or patients undergoing radiation therapy. A passive radiation detection instrument used for the personal dose monitoring or measurement of a patient dosage is a Thermoluminescent Dosimeter (TLD) (Fontenla *et al.*, 1996). Different dosimeters used for individual monitoring include film badge dosimeters, thermoluminescent dosimeters, electronic personal dosimeters, and metal-oxide-semiconductor field-effect transistor (MOSFET) dosimeters.

Workers at radiation laboratories must wear dosimeters so that their exposure level to radiation can be accurately recorded. This record is required to protect workers from the long-term effects of radiation exposure. Having only the dosimeter is insufficient unless it is used correctly and monitored regularly.

According to a study conducted by the department of radiation at TAEC, the department's primary function is to ensure that workers in various locations throughout Tanzania who work at radiation sites receive dosimeters and return them after a specified period, typically three months and one month for some few centres (*TAEC | Tanzania Atomic Energy Commission*, 2021).

Thus, TLDs provided to the workers by TAEC are currently not monitored by any online system, but records are kept manually. Therefore, it makes accurate monitoring and management of TLDs impossible due to human errors.

The proposed dosimeter management system will help users (workers) and administrators monitor and remind users when to return a dosimeter to TAEC, print individual reports from different sites, and provide information about the amount of radiation received by an individual at each site.

As a result, the proposed system will assist administrators and workers in tracking when dosimeters are dispatched and when they must be returned to TAEC. The system will also print individual reports from different locations and retrieve data on how much radiation they received at each location.

1.2 Statement of the Problem

Although various researchers (Alves, 2015; Alves *et al.,* 2004; Mauricio *et al.,* 2011; Romallosa *et al.,* 2020a) have presented and implemented dose management systems for tracking their dosimeters, most of these systems do not notify occupational workers when dosimeters expire and do not show how to dispatch and receive their dosimeters.

The current existing system presents TAEC facing the following problems: delays in sending and receiving dosimeters from and to the centres and sending reports for individual workers and institutions, poor control of data, inaccurate records, and lack of consistency of information.

Therefore, the study's goal was to develop a web-based Personal Dose management system that would streamline the dispatching and receiving procedures and serve to notify radiation safety officers (RSO) and TAEC dosimetry laboratory officers when it was time to return dosimeters to TAEC. Currently, the users of the dosimeters have to be reminded by officers using phone calls or SMS, and the schedules are not always accurately followed. Sometimes, a user can be overdosed by radiation without knowing this since records have not been kept or returned. Hence, it proves the necessity to develop the proposed system to fill the identified gaps.

1.3 Rationale of the Study

Having a proper personal dose management system in place is vital to TAEC staff and radiation department workers at different locations. The system helps dispatch and receive dosimeters' information and reminds users when to return dosimeters to TAEC to enhance effectiveness, efficiency, and ease of communication (Nordin *et al.,* 2018).

The proposed system will significantly help obtain accurate data from the people working in the radiation department and reduce human error due to manual work. This system will save workers from manual work and produce accurate results, which will help to prevent workers from unacceptable levels of radiation sources.

1.4 Objectives

1.4.1 Main Objective

The main objective of this study was to develop a system that can manage data recorded by dosimeters for the Tanzania Atomic Energy Commission.

1.4.2 Specific Objectives

(i) To identify and establish requirements for a Personal Dose Monitoring System.

(ii) To develop the Personal Dose Management System of TAEC.

(iii) To validate the developed Personal Dose Management system of TAEC.

1.5 Research Questions

(i) To develop a personal dose monitoring system, what are the requirements that must be fulfilled?

(ii) What are the most suitable methodologies to develop a personal dose monitoring system?

(iii) Is the system that has been developed in line with the users' specifications?

1.6 Significance of the Study

The proposed system will be able to notify users through mobile phones and emails. The system can help the technical support of the radiation service at TAEC to send reports to the users immediately on the level of their radiation exposure. Hence, the proposed system will provide accurate information to safeguard workers from continuously being exposed to radiation unknowingly due to human errors.

1.7 Delineation of the Study

This project is only intended to provide a personal dose web-based system to manage and monitor dosimeters and notify workers according to TAEC guidelines. This system is designed to monitor and manage workers exposed to radiation in Tanzania. As a result, the system is for the sole purpose of technical support of radiation service at TAEC to send SMS and electronic emails to the individual workers.

Due to the scope of the project, a mobile application was not developed; however, the developed online system is a mobile responsive platform.

CHAPTER TWO

LITERATURE REVIEW

2.1 Related Works

According to Alves (2015) and Alves *et al*, (2004) have proven that a database developed with MS-Access to collect annual effective dosages of people, tracked by the Individual Monitoring Service, can highlight critical characteristics.

Alves (2015) developed a database that has information on the annual effective dose for workers, which includes roughly 32 700 people who have been under ITN-observation DPRSN since the 1950s. Facilities and personnel that utilize tracking data are included in the database. Health and medical facilities are spread throughout various areas, including traditional industry, research, and mining. The practice or behavior that was reported most frequently in each category has also been identified. Additionally, significant effort needs to be put into collecting and entering all of the data relating to facilities, staff, and the appropriate dosage that other organizations operating in Portugal have documented (Alves, 2015).

According to Alves *et al.* (2004), the authors offer the databases used by the Portuguese Radiological Protection and Nuclear Safety Department (DPRSN) in the Individual Monitoring for External Radiation Service (IMS). A dosimetry system using film and another using thermoluminescent detectors are operational at the IMS (TLD).

The database has administrative features for the services and is a good interface for ordinary users. It helps determine who gets the most radiation and helps them figure out the employees with higher doses quickly. However, the researcher recommends the development of databases designed to increase the facility and worker records' closeness, which would enable easy and quick transfers of data and database updates on the National Dose Registry.

The study published by Romallosa *et al.* (2020b) reveals that workers in the Philippines have become more likely to experience occupational exposure, which has made it difficult to follow, monitor, and evaluate this exposure. As a result, the International Atomic Energy Agency (IAEA) commissioned the development of a national dose registry (NDR) to address the problem. The NDR will also act as a centralized repository of occupational external doses

whenever requested by the IAEA. This study used PHP with an open-source programming language to develop a web-based system. It gathers occupational external exposure data from IMS providers to make various reports. In addition, this investigation has not yet explained how people are accessing and sending their dosimeters to different locations.

More than 20 years ago, the Brazilian external occupational dose management system was studied (Mauricio *et al.*, 2011), and found that 120 000 workers who had been individually monitored for ionizing radiation had a centralized data store developed for individuals. A new system was built to minimize manual activities, handle tedious administrative duties, increase communication between systems, facilitate the creation of reports, and control the data storage.

A study conducted on the effects of radiation exposure on the workers in China addressed many issues in a review study. The paper also provides a fundamental analysis of the current status and issues in personal monitoring. It guides future research into individual monitoring, for instance, the development of tools such as ring dosimeters and eye lens dosimeters (Wang *et al.*, 2016).

Many researchers across the world, including researchers in Portugal (Alves, 2015), Brazil (Mauricio *et al.*, 2011), and the Philippines (Romallosa *et al.*, 2020a), have done relevant studies on dosage registry systems and national dose registries.

Still, most of these experts failed to describe dosing management and how workers are notified in those countries towards the end of wearing dosimeters. Most of the existing systems continue to be modified and added new features. Although the implemented systems are useful to their respective countries, they are customized according to the need of the specific institution. The developed system facilitates the procedures for requesting dosimeters, reminding users when to return the dosimeter, and printing quarterly and annual reports for individuals and institutions.

According to the study conducted by Hasford *et al.* (2012), the dose management system (DMS), created by the International Atomic Energy Agency, manages information on radionuclide ingestion and occupational radiation exposure. All current internal and external dosimetry data are stored, processed, and controlled by this comprehensive system. The DMS has been deployed, adapted, tested, and is currently being used as a comprehensive DMS by the Ghana Atomic Energy Commission's Radiation Protection Board (RPB) to enhance

personnel and area monitoring throughout the nation. Medical, industrial, and education/research personnel dose records from the RPBs database between 2000 and 2009 are classified into these three groups. The incompatibility of the DMS with WinREMS, the installed program for running the Harshaw 6600 TLD reader, makes system installation difficult. It is recommended that the RPB develop software that will work with both programs so that when the exposed TLDs are read with the Harshaw 6600, the WinREMS exposure readings (in mR) will automatically translate into dose values (in mSv) in the DMS.

The national dose registry for Switzerland is independent of the personal dosimetry system in place there. To guarantee that data is transferred in a secured environment, specialized data transfer solutions have been created. The database structure and informational content, for every individual patient, are all displayed (Moser, 1992). The database for the Swiss registration has been designed to utilize a current relational database system to its fullest potential. Compared to a custom design with sequential files, this approach is better able to manage cases with an unknown number of multiple records. It makes it simple to find and merge all the data about a single person that has been stored in several databases. The developed system shows the flexibility of modification for developers.

In the study conducted by Instruments and Duftschmid (1980), film dosimetry has been replaced by an automatic TLD system with computer data processing due to their well-known shortcomings, such as inaccuracy and high human needs. Since January 1977, the system has been in continuous, normal operation, providing monthly monitoring for about 13 000 radiation employees.

According to Fitousi (2017), a Dose Management System (DMS) should not be static software because of ongoing technical advancements, rationale needs, and new operational tools. Implementing a DMS becomes vital if a department strives for continual improvement. Although it takes time to utilize the tool's capabilities to their fullest, the total value makes up for it and it is provided free to member states.

Ten *et al.* (2011) presented the system would aid in identifying differences when median values result in values over Diagnostic Reference Levels as well as doses exceeding trigger levels for proper follow-up. Manual action by the operator is still needed to send the dose report to the mail server when the operations are finished. On the one hand, operators

occasionally neglect to deliver the reports, which results in the loss of the dose data. Many examination records do not include the name of the doctor or a description of the procedure.

The design and implementation of the National Dose Registry (NDR) in Canada served as the foundation for the design requirements presented in this study. The current NDR has taken into account most of the criteria presented, but not all of them (Ashmore & Grogan, 1985). Different registry design strategies can be feasible in the future due to the ongoing decline in storage costs. It might be possible to save only the essential discrete records on the optical disk, retrieve the relevant information as needed, and compute doses as needed. Such a system would have an optical reader that could automatically read several optical disks, as well as a workstation connected to a smaller local area network of workstations for information input and updating.

Researchers from many nations developed their systems with success and had an impact on their nations. However, it may be stated that the Personal Dose Management System which is accessible online is not available at TAEC. It shows the need to develop the suggested system to address the identified gap.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The study focuses on TAEC Staff, constructors, miners, radiologists, and other radioactive users. The two regions of Arusha and Kilimanjaro, located in the northern part of Tanzania, were surveyed to collect data since both have various facilities using dosimeters. These two regions were selected because they are close to the headquarters of TAEC, where research was done and there are more resources for processing dosimeters available it was easy to meet the experts at the center frequently for any urgently needed comments and inputs.

3.2 Data Collection Methods

Data collection methods for this project were carefully considered for getting the needed information. In August 2021, the data collection activity started for four weeks. This was the period used for gathering requirements from the users who are currently using the existing manual system. Various data collection techniques such as interviews, group discussions, and document reviews were employed in the process. Information from different system users was collected. This information became essential for developing the proposed Personal Dose Management system. The Technical Services and Radiation Department in TAEC is responsible for all information on dosimetry usage from all radiation workplaces for monitoring and regulating the levels of exposure to radioactive sources. Interviews were conducted with various users, and documents on the existing systems were studied. Visiting different places was conducted to interview the users of the dosimeter; the process greatly helped obtain data for the system requirements. A summary of how these strategies were used to collect data from respondents has been provided.

3.2.1 Interview

An unstructured interview with the officers working in the Personal Monitoring laboratory was conducted to understand how the existing system works. This created an avenue for understanding the challenges faced with the existing system and, in turn, provided information for developing some features included in the developed systems (Appendix 1).

3.2.2 Group Discussion

The conversations were held with the Radiation Service and Technical Support team members. The overall goal was to evaluate the existing paper-based system, the tools that track it, and how it assists those exposed to the sources. Also, other conversations focused on the difficulties that the staff members using the present system are facing (Appendix 2).

3.2.3 Document Reviews

A review was done on various publications related to the system, including training manuals and other administrative resources, which provided a better understanding of the existing system. This was done primarily to acquire a more comprehensive understanding of the system which had already been developed.

3.3 System Development Approach

Evolutionary prototyping methodology was used to develop the Personal Dose Management System Application. This method is iterative, in contrast to the other methods, which makes requirements change complicated after design; this methodology allows user/customer participation and changes to the requirements throughout the development process. Getting things done, generally follows a series of steps: development planning, selection, analysis, design, implementation, and testing (Fig. 1) (Adarsh *et al.*, 2017).

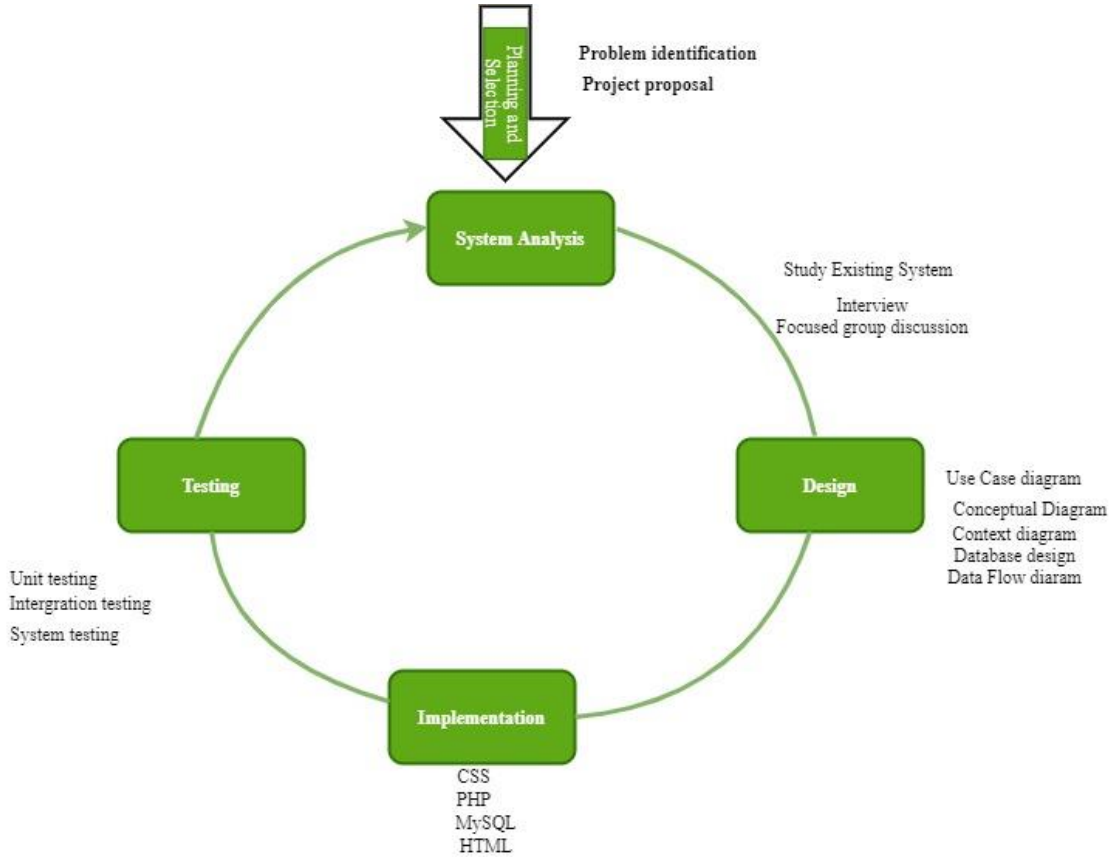

Figure 1: Development methodology

3.4 Development and Implementation of the Proposed System

The proposed system has been implemented using various tools, including HTML, CSS, Bootstrap, and JavaScript on the client-side. On the server side, PHP and MySQL were used.

3.4.1 Client-Side

(i) Hyper Text Markup Language

Data was formatted and displayed via the Hypertext Markup Language, which is abbreviated as HTML. HTML is the most used language for developing websites. Headers, paragraphs, images, and anchor tags (among others) are HTML tags. Designers used HTML to design the applications that users could use to communicate with the system.

(ii) Cascading Style Sheets

CSS is a programming language that focuses on the appearance of a website's HTML elements about its interface. HTML enables the embedding of content into the design of a

website. CSS assists this area by ensuring the content appears to the user in how it is intended to appear. CSS and other languages develop a friendly web page and improve its appearance. This is incorporated into the background design and HTML interface styling, allowing the interfaces to be visually appealing to clients, which is one of the critical components of an effective web-based system. The interface can be later customized in various ways, including changing the background images, colors, headings, and sections.

(iii) Bootstrap

Information is captured without having to hide the website's content. This is done using Bootstrap modal components. Pop-up windows appear when users click the link or button, ensuring that websites remain consistent. Bootstrap is a free and open-source web application framework. A template containing HTML and CSS components, navigation, buttons, and JavaScript additions is all about interface design.

(iv) Code igniter

Codeigniter is a development framework that helps developers write web apps in PHP. Its primary purpose is to let work on the project move more quickly than with scratch coding, as it delivers a comprehensive library set for commonly used functions, accessible interfaces, and sound structures to access these libraries. Codeigniter helps by reducing the amount of code needed for various tasks. It allows concentrating fully on the project.

3.4.2 Server-Side

(i) Cross-platform, Apache server, My Structured Query Language, Perl and Hypertext Preprocessor

XAMPP is a software package providing many functions that local servers are capable of having. It is an open-source server used locally. To start and stop the software that comes with XAMPP, XAMPP Control Panel was used. The tool was employed to assess projects and modifications before their release on the global web. Creating the MySQL database is among the most important functions offered by XAMPP. It is carried out with the use of phpMyAdmin.

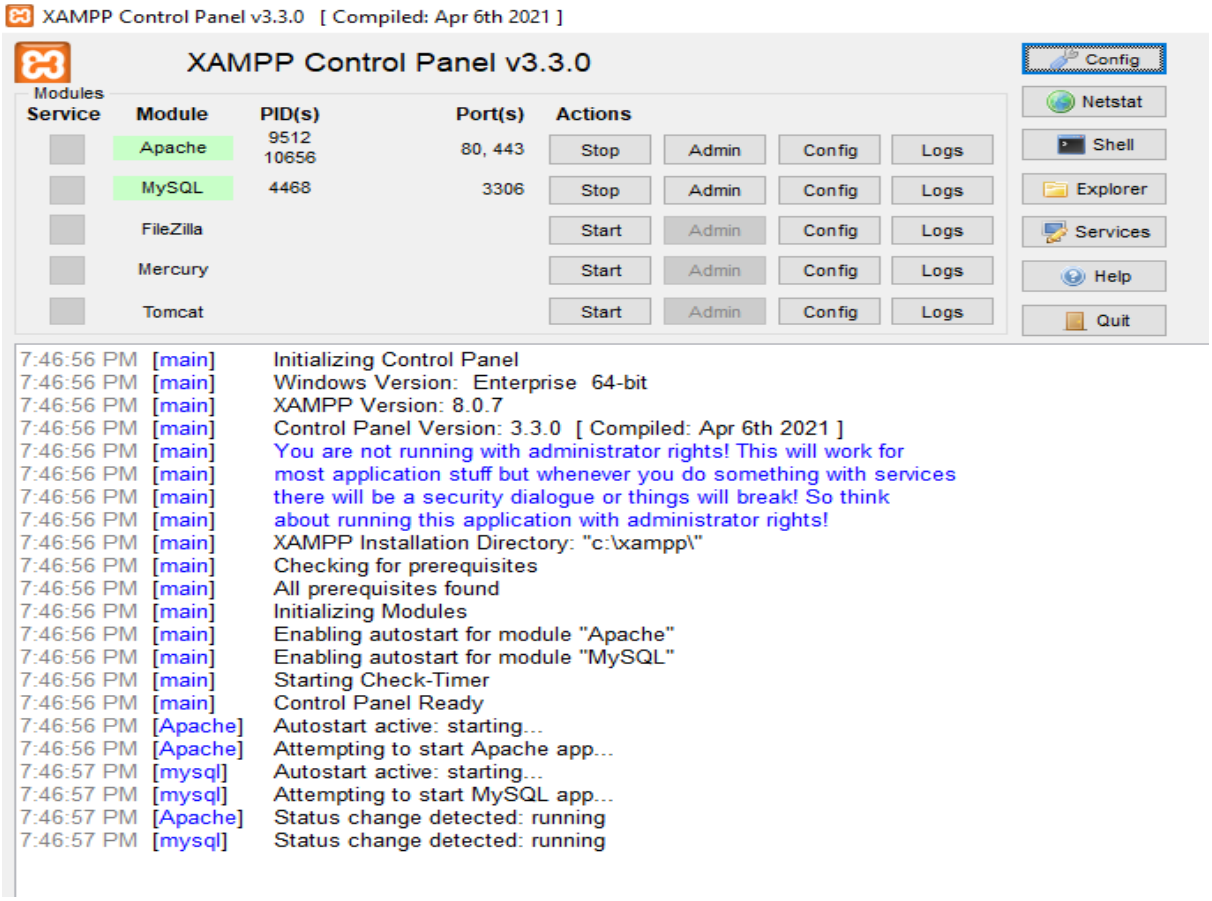

Figure 2: Xampp control panel

(ii) My Structured Query Language

MySQL currently has the most outstanding market share globally in the relational database management market. This program is provided by Oracle Corporation and is open-source database software. It is much faster, scalable, and user-friendly compared to Microsoft SQL Server and Oracle Database in its ability to administer databases. Using MySQL with PHP scripts to help develop robust and dynamic server-side or web-based enterprise applications is commonly done.

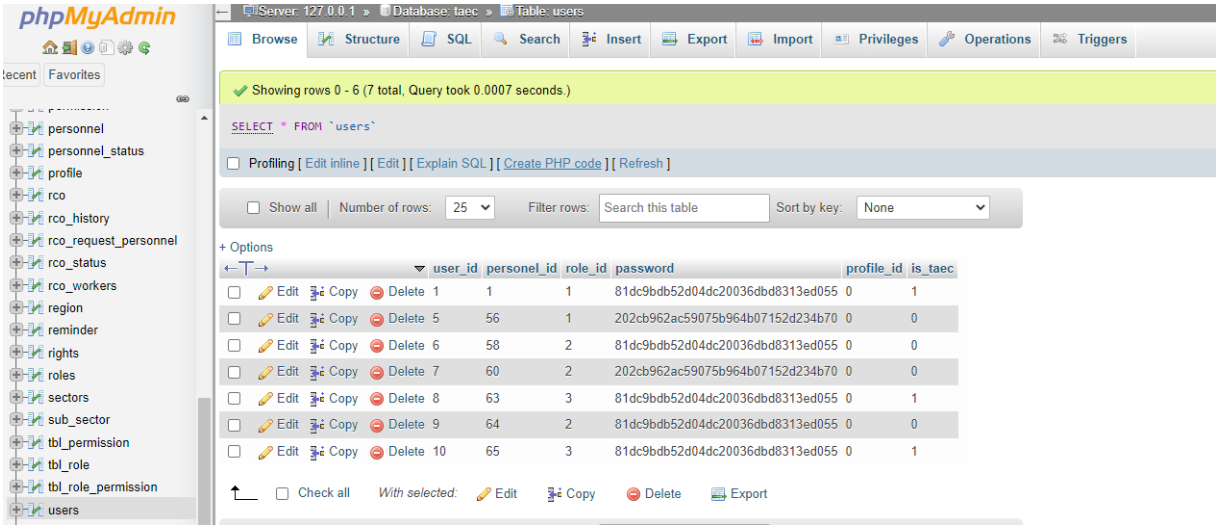

Figure 3: User's table

(iii) Hypertext Preprocessor

Websites that are interactive and collaborative are built using the Hypertext Preprocessor (PHP), a powerful technology. Server scripting is used to create dynamic browser web pages, which are then displayed to the user. We used PHP 8 for the back-end development of the software, where it was required for functions, database queries, and arrays, among other things. The form method "POST" is used to collect data, then processed with database functions before being stored in a database. The PHP script handles this procedure. Structured Query Language scripts are required to interact with the data stored in the database.

3.4.3 Assumptions and Dependencies of the Proposed System

(i) A stable internet connection is required to access the dashboard.

(ii) The system is designed for everyone who uses websites and understands how to operate their devices.

(iii) Internet connectivity is required to register and maintain users working at radioactive sources for the specific center.

(iv) Internet connection is required for registrations, personal dose monitoring, and administration to synchronize everything.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Data Collection Results

TAEC is responsible for dispatching, receiving, and printing reports on the number of dosages received by workers using a dosimeter device or detector. The current TAEC system for dosimeter uses a paper-based system to record and report the information.

During the data collection, it was recognized that the officers of the Personal Monitoring Laboratory spent much time because of manual work, and some of the data could be inaccurately recorded because of human error.

Officers involved in the discussion during the collection of data said that using the current system, there are difficulties in tracking dosimeters, poor recording of information, delays in sending reports and results, and sometimes unknowing overuse of dosimeters. Hence, having a better PDMS would enable TAEC to easily track and access workers' exposure levels to radiation sources in Tanzania.

From the interview results: The officers stated that the present system at TAEC for dispatching, receiving, and reporting is a paper-based one that includes physical tools such as logbook, calendar, dispatch, and receives forms. The logbook is used to record information about dispatching and receiving dosimeters at centers. The calendar indicates when workers should return dosimeters to TAEC. Dispatch and receive contain information about employees exposed to radiation sources for a particular institution. The respondents say that there is a lack of data consistency between workers from monthly to quarterly summaries and overuse of dosimeters.

4.2 System Requirements Results

The purpose of requirement analysis is to identify the requirements of end-users to meet their expectations from the new system, according to the specifications (Przybilski & Tuunanen, 2007). The users' requirements for PDMS were gathered and then classified into two major parts: functional and non-functional requirements.

4.2.1 Functional Requirements

In the context of functional requirements, a function is simply a system requirement. Functional requirements cover everything about how each situation works out, including what actions are taken and what will be done. Others argue that the system's expected and resulting behaviours are the functional requirements (Shankar *et al.*, 2020). The Personal Dose Management System's functional requirements are presented in Table 1.

Table 1: System verification in the data collection of the proposed PDMS

Module	Requirements	System Verification
Admin	The administrator of the proposed system will register users through this module, provide them with a username and password for the first login, and enable password change, where users will be able to browse the system.	The developed system has registered the users and can log in using their credentials.
Dispatch and Receive	All procedures in this module deal with receiving and dispatching dosimeters from employees' locations and TAEC officers.	The developed system can do all procedures for receiving and dispatching dosimeters to the centers
Registration	All dose administration will be handled through this module. Register all workers, dosimeters, institutions, and sectors.	The developed system can register different institutions, workers, types of practices, and dosimeters.
Reminder	This module will allow both system users to get alerts of end-of-use dosimeter reminders via standard messages and email.	Personal exposure to radiation sources can be reminded through this module.
Report	Staff from Technical support at TAEC will print reports for individual users, specific institutions, and the overall dose for the quarter and annual dose. Exposed workers will also be able to view their information through the system.	Reports of different centres are printed using the implemented module

4.2.2 Non-Functional Requirements

These requirements were focused on the built system and analyzing the existing system while also focused on maintenance, usability, performance, and security.

Table 2: Non-functional requirements of the proposed PDMS

Requirements	Explanations	System verification
Maintainability	The system should provide support, modification, and reconfiguration over time.	The developed system provides support and modification.
Usability	The system has to be simple to operate (interface).	The developed system proved to be GUI
Performances	The system should respond to user queries and handle multiple users.	The system was verified to handle queries and multiple users.
Security	The system should allow users to be authenticated using an encrypted password.	The developed system is provided with credentials to access the system

4.3 Results from Design

4.3.1 Conceptual Design

Conceptual frameworks are different from other analytical tools since they have various functions and contexts. Therefore, it is suitable for multiple activities, including those that need a comprehensive solution representation. Having a proper conceptual framework made the development of the proposed system easy because all of the ideas were structured and focused. The PDMS architecture comprises a category that includes all users who access the web-based system, such as occupationally exposed workers, system administrators, and TAEC staff officers.

When TAEC staff receives dosimeters from the centers, they place the dosimeter into the TLD reader, where the data is read and processed in line with the setup of the TLD reader.

The TAEC dose team then imports the data into the created dose management system. Thereafter, a system administrator and laboratory officials can manage the newly created system. Workers that are exposed due to their occupations can interact with the system.

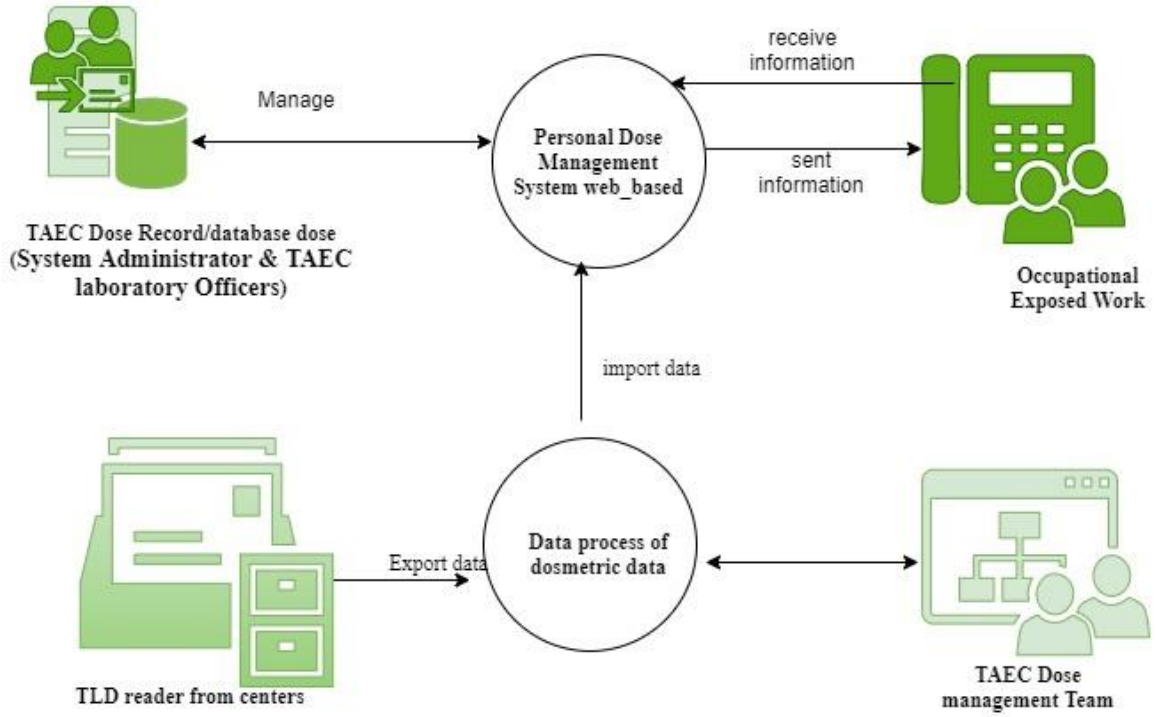

Figure 4: Conceptual design for the proposed system

4.3.2 Context Diagram

The design of the proposed system consists of three users, as shown in the context diagram that shows the overall description of the system (Fig. 5). Sometimes this diagram is called the "level 0" diagram. It also shows the interaction of the system with external entities. (Niepostyn, 2019).

Figure 5: Context diagram of the system

4.3.3 Data Flow Diagram

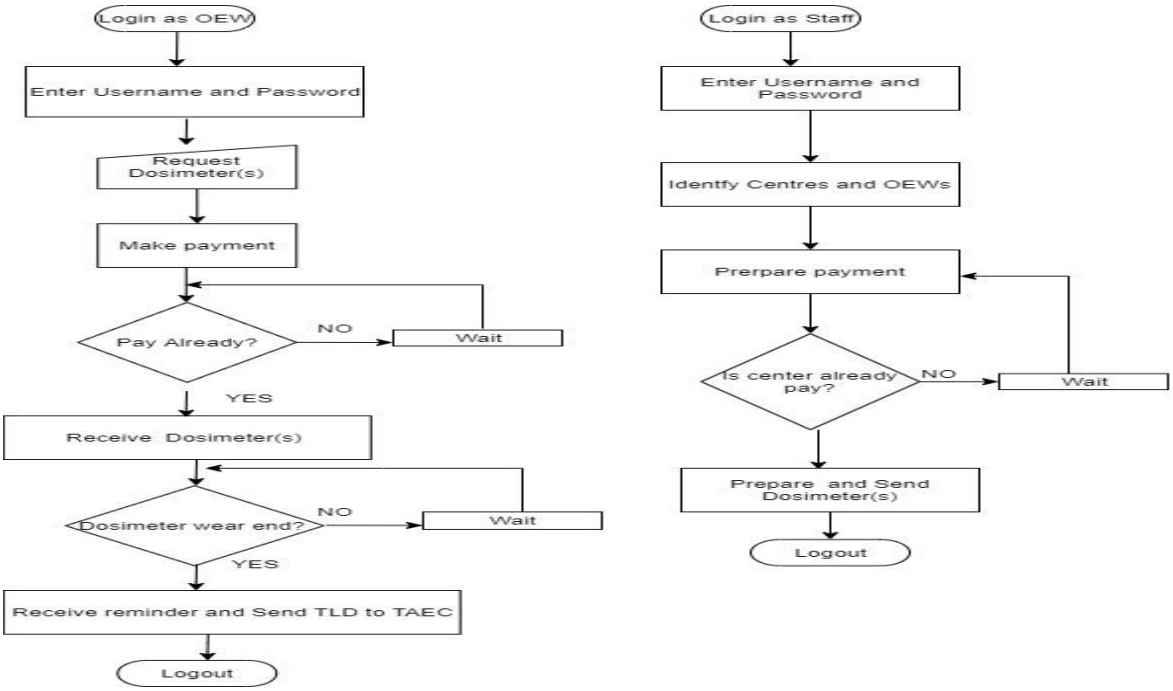

Figure 6: Data Flow Diagram

4.3.4 Database Design

To create a database, one must plan out its schema or schema design. It involves figuring out what defines an entity, determining its relation to other entities, and identifying its attributes. The database designer decides what data to store and how to relate it to other data. Classifying data and determining its interrelationships is database design.

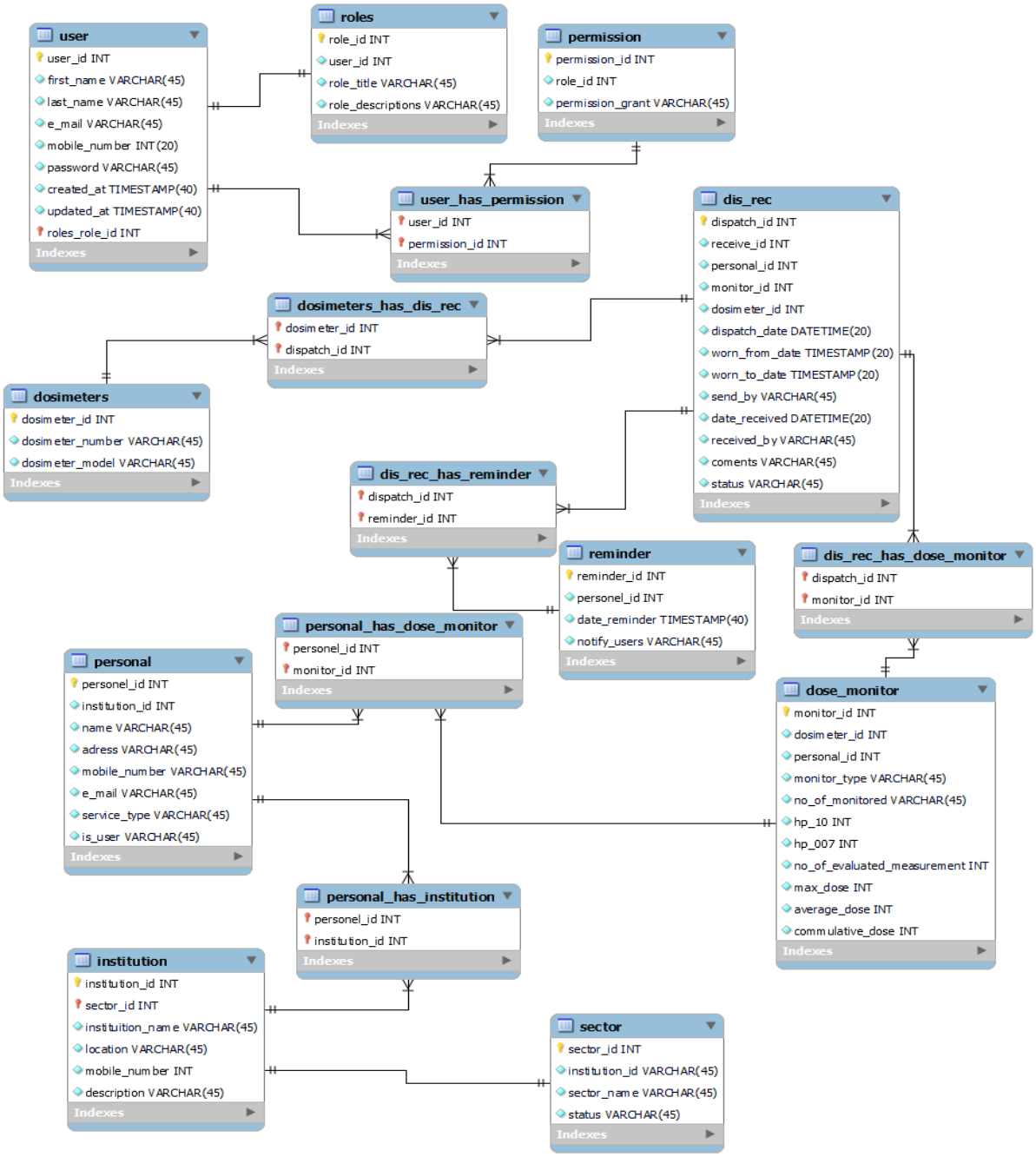

Figure 7: Database design of the PDMS

4.3.5 Use Case Diagram

A Use Case Diagram depicts the interaction between users and the system. It defines the procedures a user can carry out. Actors represent entities outside of the use case, and use cases represent the things the use case does.

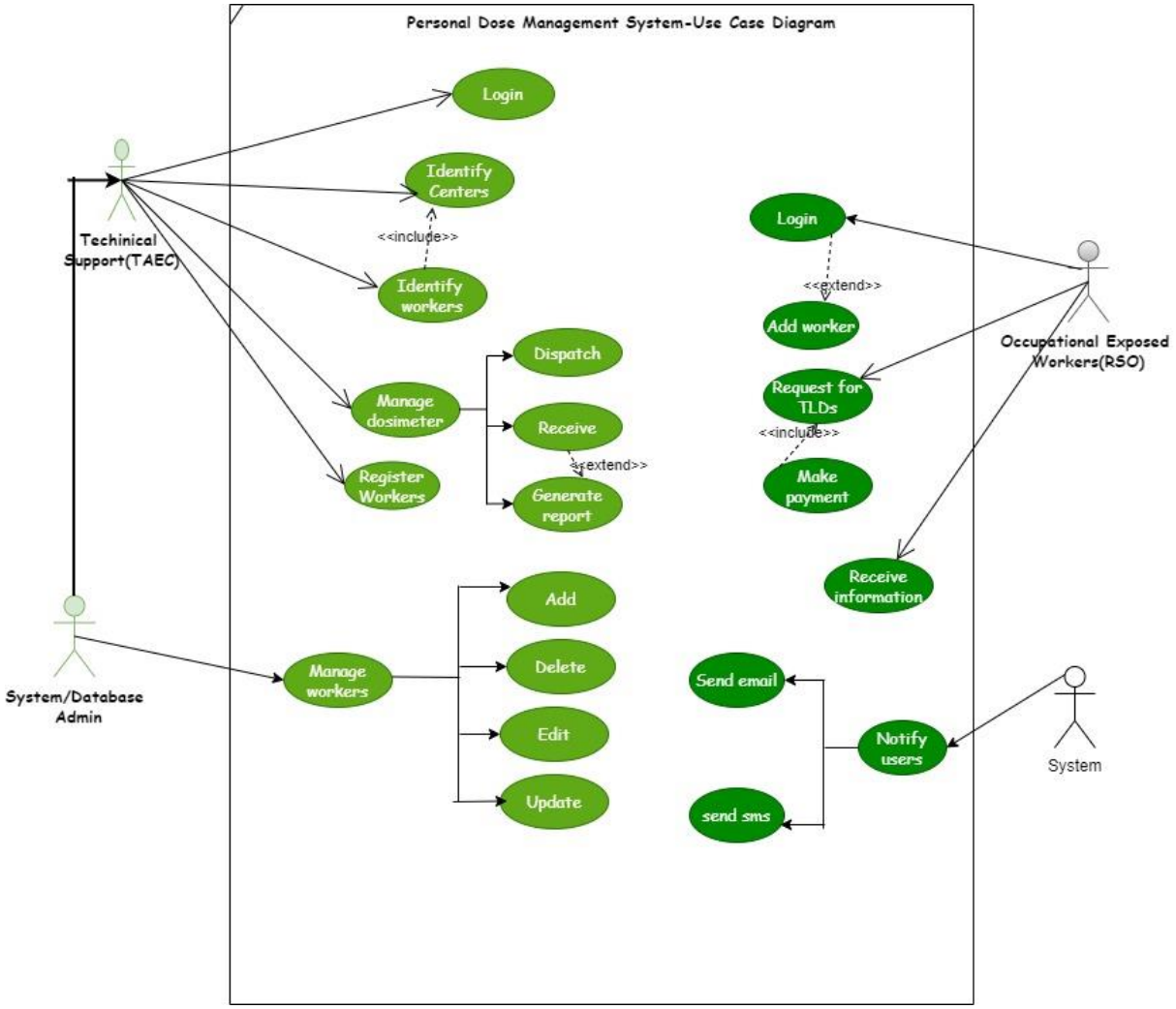

Figure 8: Use case diagram

The users of the system are the technical support officers, system administrators, and radioactive workers. Log in to the system, and identify the number of workers and access records. Request for a dosimeter; a notification message will be sent through email once the payment is sent. System Administrators manage the radioactive workers, view status, generate a report, and register users.

4.4 The Developed Personal Dose Management System at TAEC

Personal Dose Management System is meant to provide better interaction with all of its users; hence it incorporated a Graphical User Interface (GUI). It is required to save data in an electronic online form for online data retrieval and improve the process. Users would complete the form correctly and use various interfaces to find relevant information, such as downloading and viewing information online. The Personal Dose Management System is

only accessible to individuals who have registered on the system. Individuals who have not registered on the system will be unable to access the functionalities. Figure 9 shows a designed login interface where users with a range of functionalities must enter the correct username and password to interact with the system according to their user rights. The Personal Dose Management System has the following modules: Login interface, Registration, dispatch and receive, admin, and report module.

4.4.1 Registration Part

After the administrator has successfully logged into the system, the registration process begins. Before a user uses the system, the administrator can register various dosage management operations, such as sector, institution, dosimeter, and personnel adds because it allows the administrator to create an account for system users.

First and foremost, a user must log in with the username and password that the administrator has assigned. Once users have logged in, they will be redirected to the appropriate pages based on their roles. Figures 9 through 12 show several screenshots of the registration section of the application that was demonstrated.

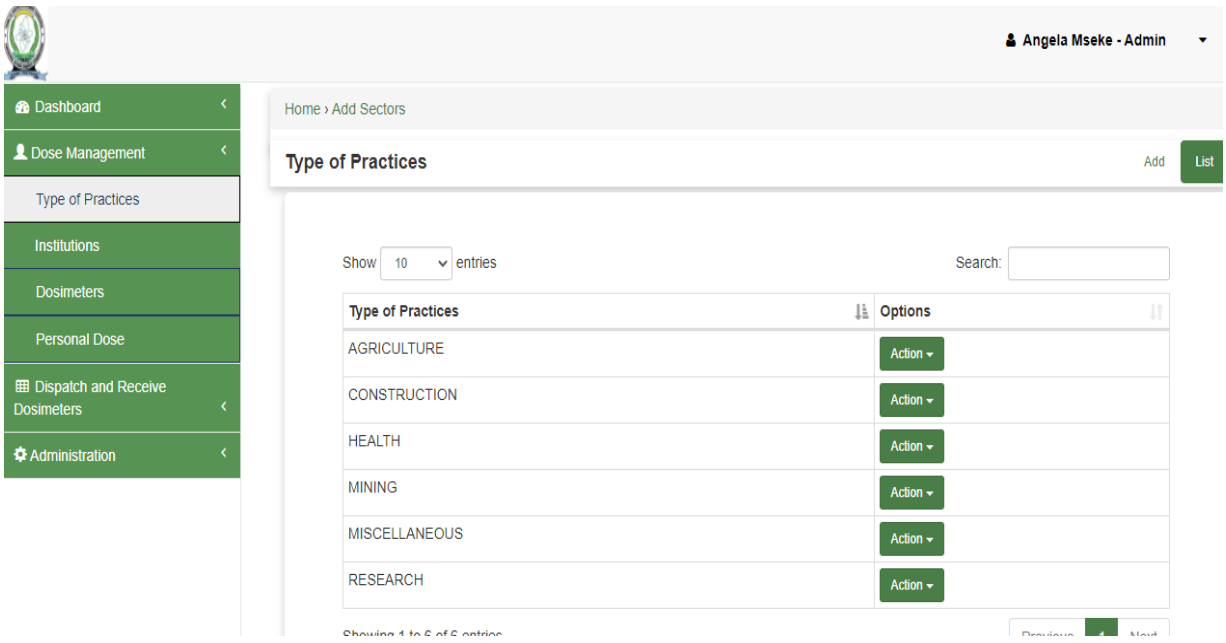

Figure 9: Sector registration

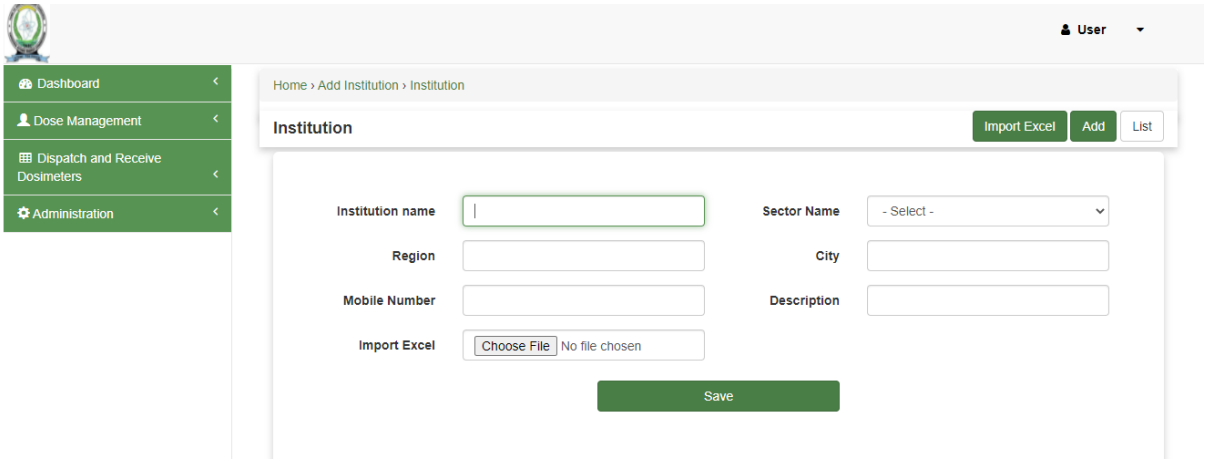

Figure 10: Institution registration

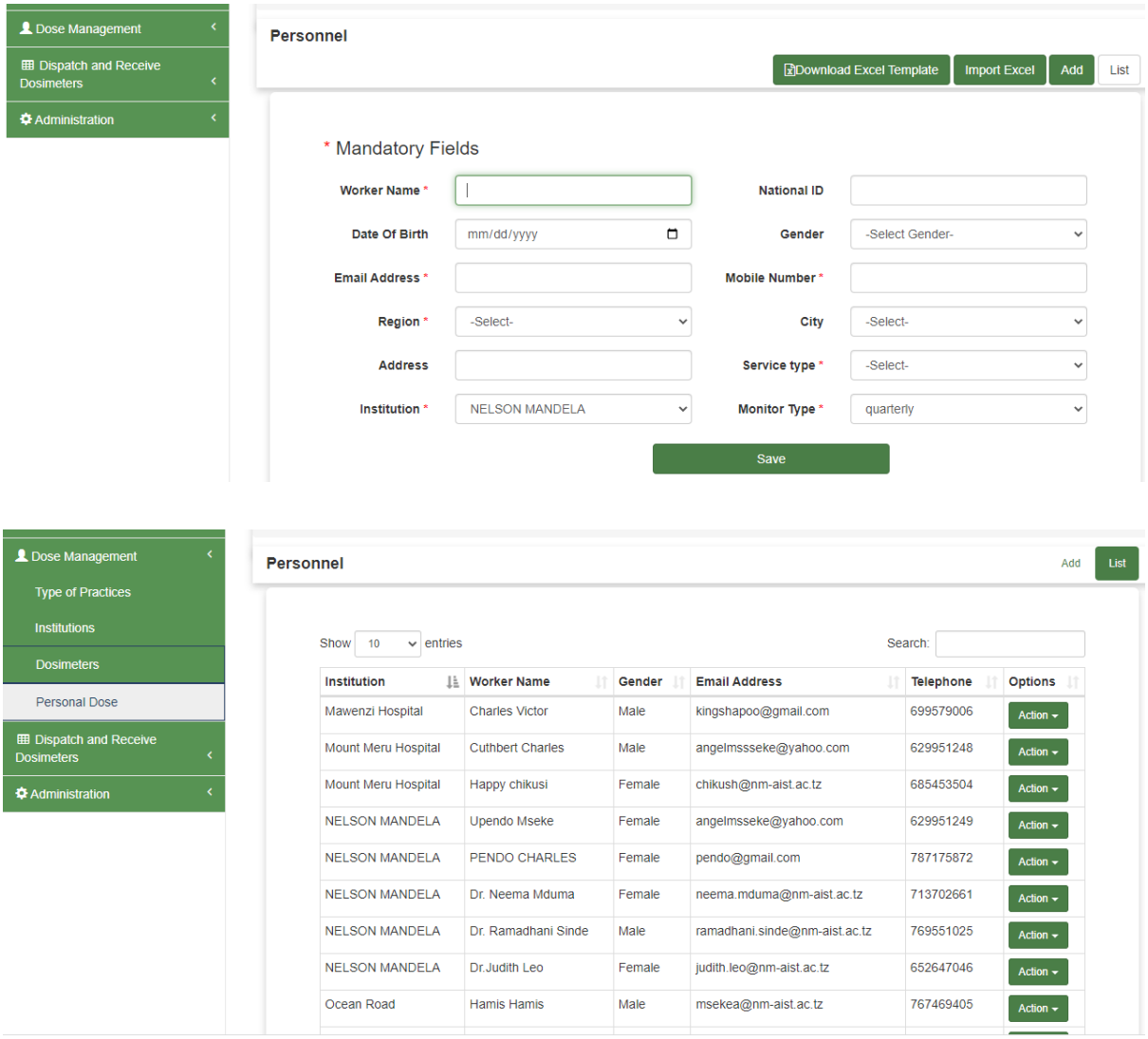

Figure 11: Personal registration and view

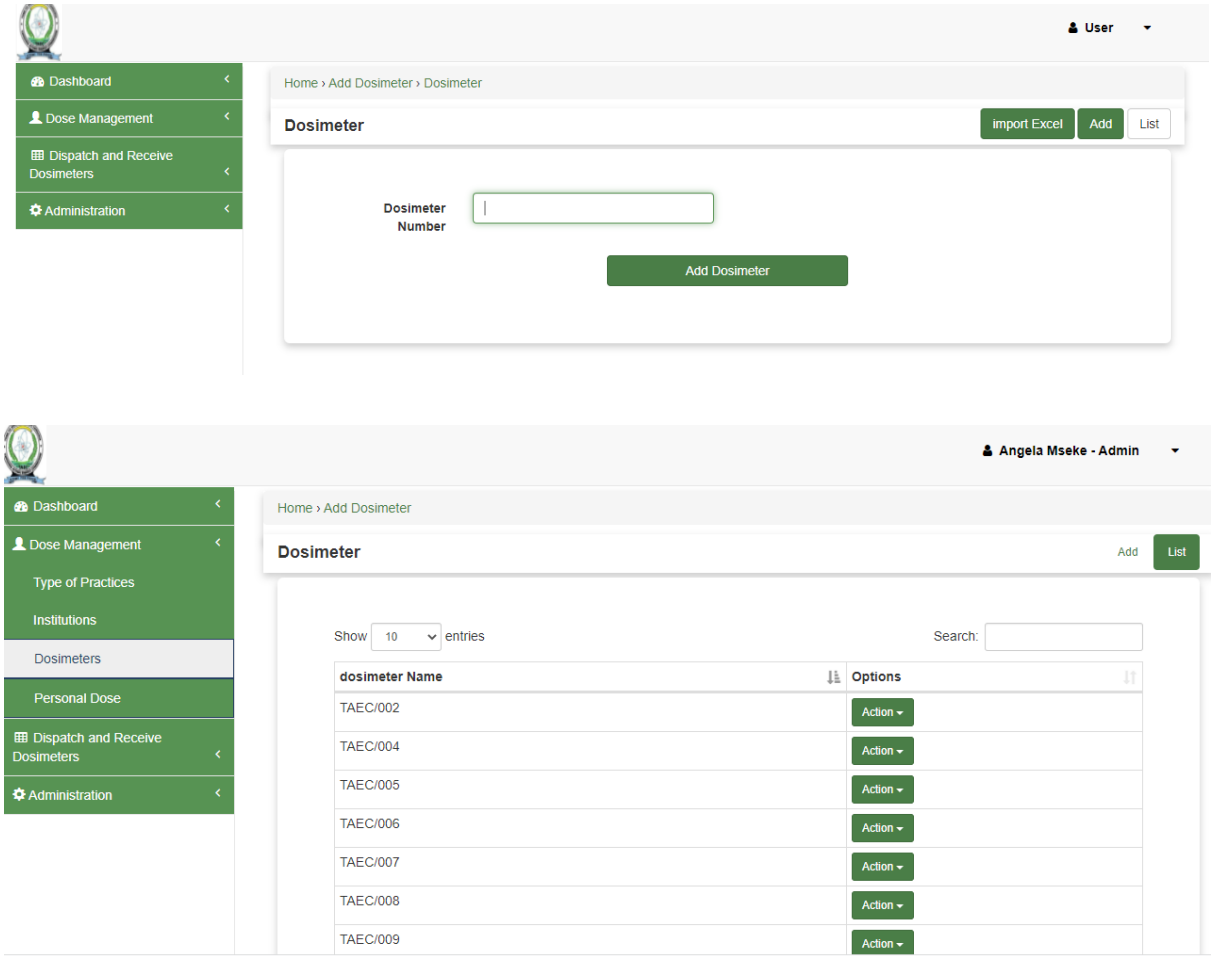

Figure 12: Dosimeter registration and view

4.4.2 Login Interface

All users shall be able to access the system through a single login homepage. Each user is required to enter their username and password to access the rights assigned to them by the administrator. Users are directed to a specific page according to their user rights.

The first page of PDMS is a dashboard page with different menus for different roles in the system (Appendix 3).

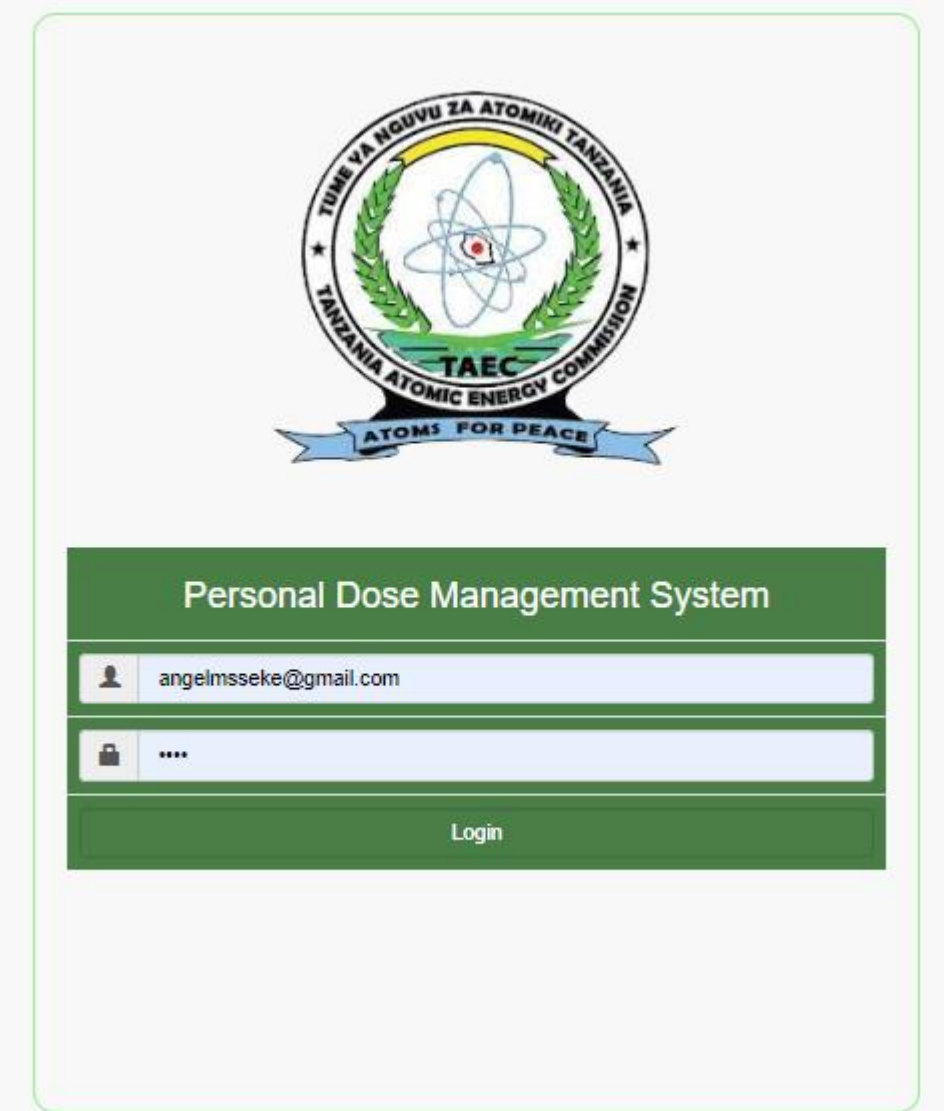

Figure 13: Login interface

4.4.3 Admin

Once logged in, the admin can access all the registered system users of the dose and know their current status. The PDMS configurations panel is only accessible to the system administrator, who can navigate and access all of the system's menus. The administrative panel is shown in Fig. 14.

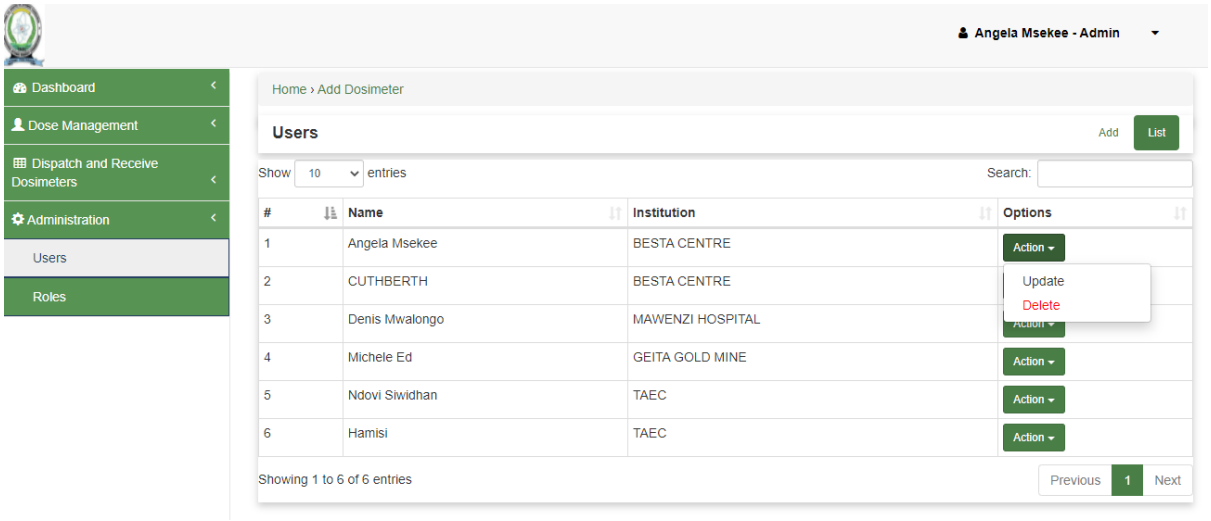

Figure 14: Panel for the system admin.

4.4.4 Dispatch and Receive

After logging into the PDMS, both exposed occupational workers and TAEC staff can access information about the status of dosimeters being received and dispatched. Occupationally exposed workers can view when their dosimeters will be received and returned to TAEC. The TAEC staff is responsible for identifying centres that require dosimeters and identifying the number of workers exposed to radiation sources. For instance, if the institution is selected from the system, the user can view its status.

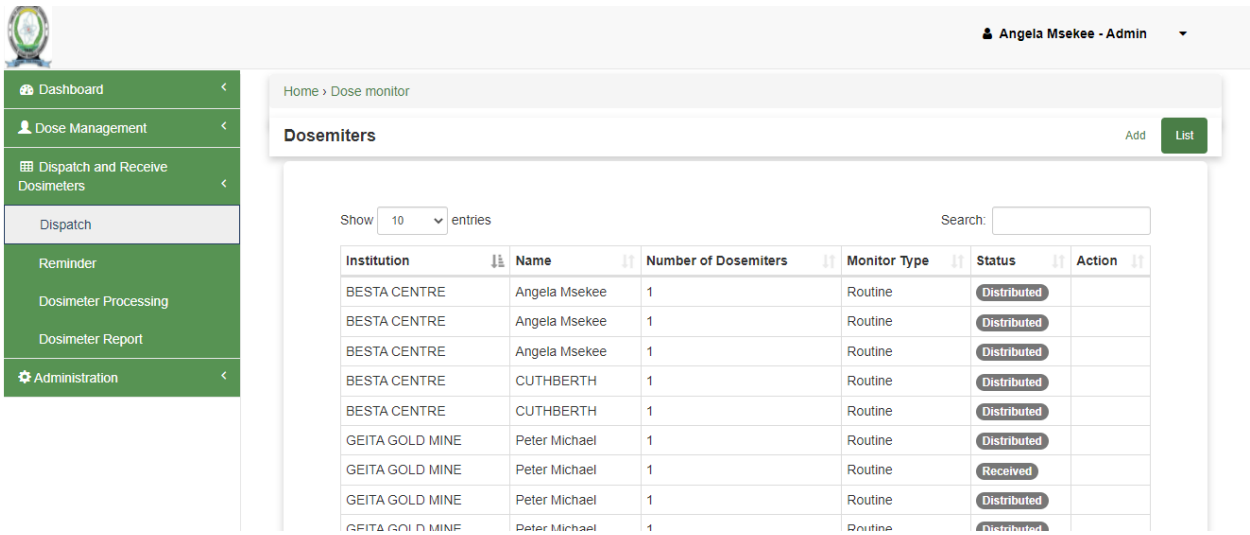

Figure 15: Distributed dosimeters to some institutions

4.4.5 Reminder

This module will help notify exposed individuals when the time for wearing a dosimeter will end. Therefore, it will send emails and messages to the individuals exposed to radiation sources. In this case, PDMS is set to notify individuals two weeks before the end of their dosimeter use (Appendix 3).

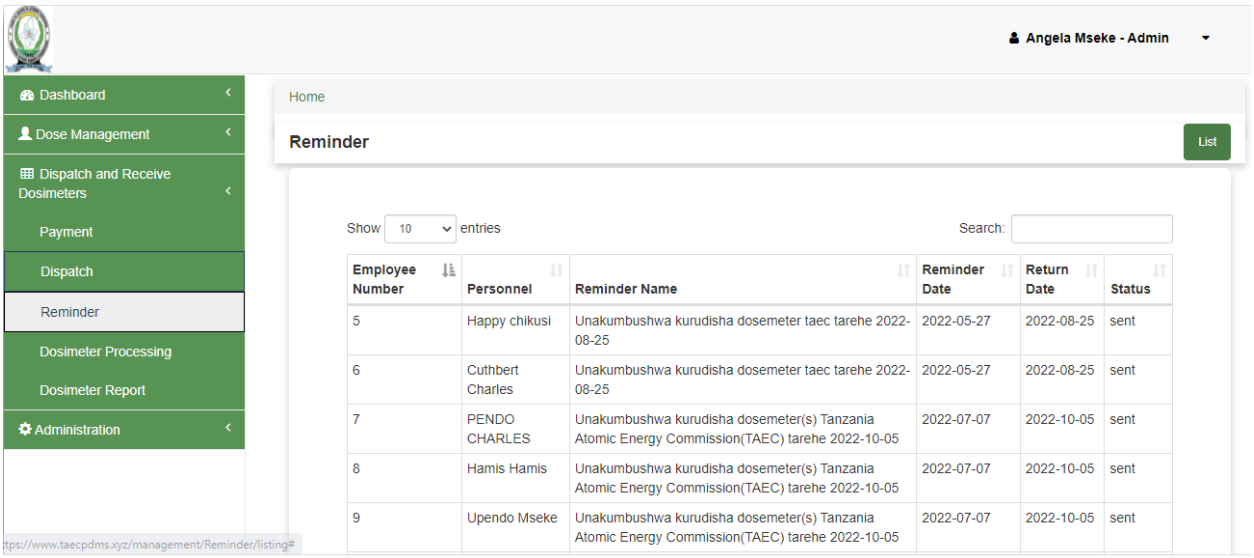

Figure 16: Visualize the date to notify users

4.4.6 Reports

The dose report module allows the intended individuals, such as exposed workers and staff, to view, download, and print reports in pdf format relating to particular institutions, sectors, and individual dosage reports. Figure 16 shows examples of reports that may be printed from PDMS.

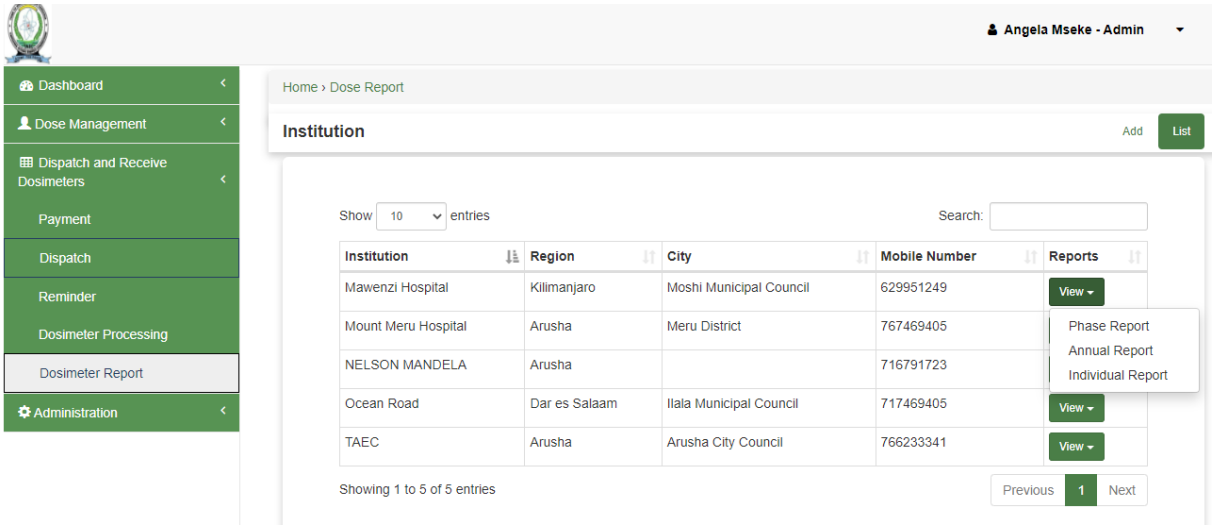

Figure 17: Report for phase, annual and individual

4.5 Results from System Validation

Validation is the process of evaluating and testing essential criteria that the specifications for a system are relevant to the purpose for which they have been designed. In this case, the user specifications and needs are checked to ensure that they are met. So validation can be defined as the process of verifying that specifications were correctly presented and demonstrating that the required system specifications have been fulfilled (Kamalrudin & Sidek, 2015).

4.5.1 Unit Test

One form of software testing is called unit testing. It involves testing each component of the product. The aim is to prove that every section of the code operates as planned. When coding an application, developers run unit tests. The unit tests prove that the standalone code is correct. An item can be any of the following: a method, operation, module, object, or function (Guru99, 2021). For example, a user registration module, a dispatch and receive module, an admin module, and a report module were tested. To ensure that each module functioned, the testing team made sure that they logged in to the developed system and thoroughly tested every module for proper functionality.

4.5.2 Integration Test

After doing a test run for each module, it will be followed by integrated system testing, which involves testing all modules as a single unit to determine the overall results of the system. This test aims to identify compatibility issues in the integrated modules. The radiation safety

officer in the organization will first test the login module.

4.5.3 System Test

A system test is a method of testing an entire system. Testing checks whether the final system fulfills user requirements and meets expectations. The system testing stage confirmed the success of all the modules' attempts in one test. Thus, the system as a whole was tested and verified to operate as intended.

Table 3: System testing results

Requirements	Descriptions	Tested by	Date tested	Status
Login Interface	Test whether PDMS users are authorized by inserting a username and password	Denis Ndovi Hamis Sara Adam Adam	27 November 2021	Pass
Admin	This module tests whether the admin can enter the configuration panel and navigate all interfaces.	Adam Ndovi	27 November 2021	Pass
Dispatch and receive	Tests the dispatching and receiving processes using the management system.	Denis Ndovi Hamis Sara	27 November 2021	Pass
Reminder	This module reminds the dosimeter user of when to return the dosimeter for calibration.	Adam Ndovi RSO's	ovember 7,2021	Pass
Report	Tests whether the system can generate a report, and allow viewing and printing.	Denis Ndovi Hamis Sara	27 November 2021	Pass
Logout	Tests whether login sessions are terminated.	Denis Ndovi Hamis Sara Adam Adam	27 November 2021	Pass

4.5.4 User Acceptance Testing

Users who will be using the developed system will be involved in testing the system against data collected from dosimeters to ensure that they meet customer needs. In this scenario, the system's three users were tasked with evaluating the web-based application to see whether it was ready for use and deployment in the real environment before it could be used and deployed. According to the responders, the procedure was exceptional and had the potential to yield better results. Several important improvements were made, including increased efficiency at TAEC, improved management control, improved communication, a quicker reporting process, and easier access. The PDMS that is developed is intended to manage data gathered by dosimeters. One of its key responsibilities is to remind dosimeter users to return dosimeters to TAEC, in addition to sending and receiving dosimeters as well as printing reports. The developed system is user-friendly (graphical user interface), and users must be connected to the internet to access PDMS content. Table 4 shows six respondents' user acceptance testing results for the system.

Table 4: User acceptance testing results

No.	Acceptance Requirements	Number of people	
		Accept	Reject
1	Six users checked the system by using their valid emails and passwords.	6	0
2	The system is user-friendly and easy to use.	5	1
3	Dosimeter users who received SMS notifications were tested with six people.	6	0
4	Dosimeter users who received Email notifications were tested with six people.	6	0
5	Print reports of individual and institution	6	0

4.6 Discussion

The developed PDMS tried to satisfy all of TAEC’s standards. The system's graphical user interface (GUI), designed expressly for managing data from dosimeters, is user-friendly and interactive. Its applicability accomplishes the objective through dosimeter services, which process dosimeter data and make it readily available in an online version. Users must have internet access and log in using the username and password they created during the registration process. The developed system shows different stages of processing dosimeters from Radiation Safety Officers to the TAEC office. The developed system showed processes such as dosimeter request, payment, payment approval, dosimeter dispatch, receipt of dosimeter, distribution to the exposed workers, and reminding users on when to return dosimeters to TAEC. Most of the existing systems do not have all the features developed in PDMS for example Researcher Alves, 2015 suggests more features should be added to the existing systems because the other systems do not show the processes of accessing and sending dosimeters to different centers.

According to the study, the system has successfully created reports on specific institutions exposed to radioactive sources. Thorough tests were conducted to validate the system, and it appeared that the objectives of the system were satisfactorily met. Additionally, any non-functional issues identified during the development process were resolved at the time. As a result, it is believed that the project has been satisfactorily accomplished with all web-based personal dose management system's functional and non-functional objectives.

CHAPTER FIVE

CONCLUSION AND RECOMMANDATIONS

5.1 Conclusion

The developed system, known as PDMS, was presented in the study, followed by system testing. Deployment and validation. According to the results, the developed system will increase efficiency while decreasing manual work at TAEC. The system will help individual employees who have been exposed to radiation sources and they will be routinely monitored. The developed system allows the management of data collected by dosimeters, but it also allows the administrator to add information about sectors, institutions, and dosimeters and register occupational employees exposed to radiation. Following that, users of all types will be able to log into the system and navigate to the appropriate page based on their respective roles.

5.2 Recommendations

The developed system minimizes workload and enables TAEC officers to speed up the procedure of processing dosimeters from dispatch to generation of the reports on radiation level for each exposed individual. The web-based management system built was beneficial to various stakeholders, including the health sector, mining, industries, and TAEC officers, and in tracking individual workers' reporting and tracking dosimeter usage periods. Other researchers are invited to add more modules not yet implemented for future purposes, such as online payment, a mobile application that can work in online and offline environments, and tracking modules. The additional modules will be required to enable monitoring of an individual's dosimeter readings and time spent in a particular area via GPRS and other technologies.

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APPENDICES

Appendix 1: Interview questions

1. Is a paper-based system bringing challenges to TAEC officers and workers in their working environment? Give your answer below.
2. What is the challenge(s) of using paper-based system monitoring dose in different sites?

   Mention them.
3. How would you like to communicate with an Occupational Exposed Worker when notifying them? Which means of notifying do you prefer?
4. Do you have any other information you would like to share to improve the existing system?
5. Will it be convenient if an automated system is developed to assist in managing the period of using dosimeters, printing reports, and other particulars?
6. Which features of a Personal Dose Monitoring System do you think are helpful to workers and TAEC? (Please mention all that apply)

Appendix 2: Group discussion

1. What information is needed to register new users of dosimeters at TAEC?
2. What reminder system is currently being used to report end-wearing dosimeter?
3. How did dosimeter users get their reports after recording their level of exposure?
4. Who is responsible for requesting and distributing the dosimeter to the centre?
5. Do you have any challenges (s) in using the existing system?
6. What do you think is contributing to the challenges in managing data recorded by dosimeter using the existing system?

Appendix 3: Login and reminder codes

```
<?php
defined('BASEPATH') OR exit ('No direct script access allowed');
class Login extends CI_Controller {
   public function __construct() {
      parent::__construct();
   }
   public function index($params = NULL) {
            // ********** notifications codes**********
   $this->load->database();
   $query = $this->db->query('SELECT * FROM reminder WHERE status = "not sent"');
   foreach($query -> result() as $row){
      $reminder_id = $row->reminder_id;
      $personel_id = $row-> personel_id;
      $reminder_name = $row->reminder_name;
      $date_reminder = $row->date_reminder;
      $status = $row->status;
      // if($status <>'sent'){
      if ($status=='not sent') {
            if($date_reminder == date("YYYY-MM-DD")){
                  $queryPersonal   = $this->db->query('SELECT * FROM personnel
where `personnel_id` =  "'.$personel_id.'"');
            $resultsPersonal = $queryPersonal->result();
            foreach($resultsPersonal as $person){
               $p_id = $person -> personnel_id;
               $worker_name = $person -> worker_name;
               $telephone = '255'.$person -> telephone;
               $e_mail = $person -> e_mail;
               // echo $telephone;

                  // **********sms function hapa*******
```

```
$curl = curl_init();
curl_setopt_array($curl, array(
  CURLOPT_URL => 'https://messaging-service.co.tz/api/sms/v1/text/single',
  CURLOPT_RETURNTRANSFER => true,
  CURLOPT_ENCODING => '',
  CURLOPT_MAXREDIRS => 10,
  CURLOPT_TIMEOUT => 0,
  CURLOPT_FOLLOWLOCATION => true,
  CURLOPT_HTTP_VERSION => CURL_HTTP_VERSION_1_1,
  CURLOPT_CUSTOMREQUEST => 'POST',
  CURLOPT_POSTFIELDS =>'{"from":"NEXTSMS", "to":"'.$telephone.'",  "text":
'".$reminder_name."'}',
  CURLOPT_HTTPHEADER => array(
    'Authorization: Basic QmlsbDM2MDpiZWNrZXQjMzYw',
    'Content-Type: application/json',
    'Accept: application/json'
  ),
));
$response = curl_exec($curl);
//print($response);
// echo $response;
if($response){
   $queryPersonal   = $this->db->query('UPDATE reminder SET `status` = "sent"
WHERE reminder_id = "'.$reminder_id.'"');
   $from_email = "angelmsseke@gmail.com";
   $to_email = $e_mail;
   // echo $to_email;
   $this->load->library('email');
   $this -> email->from($from_email, "Tanzania Atomic Energy Commission");
   $this -> email ->to($to_email);
   $this -> email->subject('TAEC_PDMS');
   $this -> email->message($reminder_name);
```

```
            $this->email->send();
                    }
        // ******* end of sms function**********


                }
            }
        }
    }
// ************end of notification codes*********
//print_r($this->session->set_userdata('REPORTING'));exit();
        if (!empty($this->session->userdata('taec_email'))) {
         if($this->session->userdata('taec_REPORTING') <> 1){
         redirect(base_url()."management/Dosimeter/listing");
         } else redirect(base_url()."Reporting");
        } else {
            $datas['message'] = $params;
            $this->load->view('Login_Views', $datas);
         }
    }
    public function do_login() {
        $login = $this->input->post('USERNAME');
        $password = $this->input->post('PASSWORD');
                $critere1['e_mail']=$login;
               $personnel= $this->Model->getOne('personnel',$critere1);
        $critere2['personel_id'] = $personnel['personnel_id'];
        $users = $this->Model->getOne('users',$critere2);
                    if (!empty($login)) {
                        if ($users['password'] == md5($password))
            {
                            $session = array(
                        'taec_users_id' => $users['user_id'],
                        'taec_email' => $login,
```

```
                    'taec_EOWs'=> null,
                    'taec_PERSONAL_MONITORING_OFFICERS'=>0,
                    'taec_ADMIN'=>0,
                    'taec_REPORTING'=>0
                                    );
//print_r($session);
//die();
                $this->session->set_userdata($session);

               if($this->session->userdata('taec_REPORTING') <> 1){
            redirect(base_url()."management/Dosimeter/listing");
        } else redirect(base_url()."Institution");
      }
           else
             $message = "<div class='alert alert-danger'> The incorrect username or
password(s) !</div>";
       }
        else
          $message = "<div class='alert alert-danger'> The user does not exist / no longer in
our IT system !</div>";
      $this->index($message);
   }
   public function do_logout()
          {
                    $session = array(
                    'taec_users_id' => null,
                    'taec_email' => NULL,
                    'taec_EOWs'=> null,
                    'taec_PERSONAL_MONITORING_OFFICERS'=> NULL,
                    'taec_ADMIN'=> NULL,
                    'taec_REPORTING'=> NULL
                     );
```

```
            $this->session->set_userdata($session);
            redirect(base_url('Login'));
        }
    public function save_download ()
  {
      //load mPDF library
      $this->load->library('M_pdf');
      //load mPDF library
       //now pass the data//
       $this->data['title']="MY PDF TITLE 1.";
       $this->data['description']="Example of a pdf generator";
       //$this->data['description']="";
       //now pass the data //
       $html=$this->load->view('pdf_output',$this->data, true); //load the pdf_output.php
by passing our data and get all data in $html varriable.

      //this the the PDF filename that users will get to download
      $pdfFilePath ="mypdfName-".time()."-download.pdf";
       //actually, you can pass mPDF parameter on this load() function
      $pdf = $this->M_pdf->load();
      //generate the PDF!
      $pdf->WriteHTML($html,2);
      //offer it to users via browser download! (The PDF won't be saved on your server
HDD)
      $pdf->Output($pdfFilePath, "D");
  }
}
```

Appendix 4: Admin and TAEC Dosimetry officer dashboard

```
<?php
defined('BASEPATH') OR exit('No direct script access allowed');
class Dashboard extends CI_Controller
{
        public $CI = NUll;
   public function __construct()
    {
      parent::__construct();
     $this->CI = & get_instance();
          $this->load->model('Model');
   }
   public function is_Oauth()
   {
      if($this->session->userdata('EMAIL') == NULL)
      redirect(base_url());
   }
   function get_report(){
      // $sql = "SELECT `institution_id` FROM `personnel` WHERE `personnel_id` in (SELECT `personal_id` FROM `dose_monitoring` GROUP BY `personal_id`) GROUP BY `institution_id`;";
      $sql1 = "DROP TABLE institution_dose"; // remove the existing temp table
      $this->db->query($sql1);
     $sql2 = "CREATE TABLE institution_dose AS SELECT AVG(commulative_dose) as commulative_dose,personal_id, institution.institution_id FROM dose_monitoring,personnel JOIN institution on institution.institution_id=personnel.institution_id WHERE dose_monitoring.personal_id = personnel.personnel_id GROUP by personal_id "; // retrive data and recreate temp table

     $this->db->query($sql2);
```

```
$sql3="SELECT SUM(`commulative_dose`) as commulative_dose,institution_dose.`institution_id`,institution_name FROM `institution_dose` join institution on institution.institution_id= institution_dose.`institution_id` GROUP BY `institution_id`;"; // retrieve data from the temp table
$institution = $this->Model->getRequete($sql3);

//print_r($institution);exit();
$datas['series'] =' series: [
{ name: "Institutions",
   colorByPoint: true,';
$data = 'data: [';
$sub_data ='';
foreach ($institution as $key => $institution_one) {
$data = $data.',{
        name: "'.$institution_one['institution_name'].'",
        y: '.$institution_one['commulative_dose'].',
        drilldown: "'.$institution_one['institution_name'].'"
      }';
 $sub_data .='{
      name: "'.$institution_one['institution_name'].'",
      id: "'.$institution_one['institution_name'].'",
      data: [';
$sql4 = "SELECT `commulative_dose`,`personal_id`,institution_dose.`institution_id`,worker_name FROM `institution_dose`,personnel WHERE `personal_id`=personnel.personnel_id and institution_dose.institution_id= ".$institution_one['institution_id'];

$personnel_dose = $this->Model->getRequete($sql4);

      foreach ($personnel_dose as $key => $personnel) {
        // code...
```

```
                $sub_data.='[
                    "'.$personnel['worker_name'].'",
                    '.$personnel['commulative_dose'].'
                ],';

    }
        $sub_data .='//';
   $sub_data = str_replace(',//', '', $sub_data);
        $sub_data .= ']},';

 }
   $sub_data .='//';
   $sub_data = str_replace(',//', '', $sub_data);
   $sub_series = ' }
  ],drilldown: {
      series: ['.$sub_data.']}';
   $data = str_replace('[,', '[', $data);
    $data .= ']';
    $datas['series'].= $data.$sub_series;
    $datas['date_report'] ='On '.date("l").', '.date("d-m-Y");
     //print_r($date_report);exit();
      $this->make_bread->add('Dashboard', "Dashboard/get_report", 0);
      $datas['breadcrumb'] = $this->make_bread->output();



  $this->load->view("Dashboard_View",$datas);
  }
function test(){
     $this->load->view("newDashboard_View");
}
  function index()
```

```
  {
   // print_r($this->session->userdata($session));exit();
    $dats=$this->Model->getList('stock',array());
          $qte_acha = "{'name':'Qté totale.',data:[";
          $qte_rest = "{'name':'Qté restante ',data:[";
          $qte_vendu = "{'name':'Qté vendue ',data:[";
                  $categori ='';
       $categori .='//';
       $categori = str_replace(',//', '', $categori);
       $qte_rest .='//';
       $qte_rest = str_replace(',//', ']}', $qte_rest);
        $qte_acha .='//';
       $qte_acha = str_replace(',//', ']}', $qte_acha);
       $qte_vendu .='//';
       $qte_vendu = str_replace(',//', ']}', $qte_vendu);
    $datas['seriebar'] = $qte_acha.','.$qte_rest.','.$qte_vendu;
    $datas['categori'] = $categori;
    $datas['breadcrumb'] = $this->make_bread->output();
    $datas['id']="";
   $datas['title']="Medicament";
  $this->load->view("Reporting_View",$datas);
  }
 function Rapport_index()
  {
    $id = $this->uri->segment(3);
          //$datas['user']=$this->Model->getOne('user',          array('USER_ID'=>$this-
>session->userdata('USER_ID')));
          $qte_init = "{'name':'Qté Totale.',data:[";
          $qte_finale = "{'name':'Qté Restante ',data:[";
          $qte_rest = "{'name':'Qté Vendue ',data:[";
                  $categori ='';
   }
```

```
function get_report_inst(){
        $this->load->view('dashboard_view_inst');
}
        function get_data($table){
        $data = $this->Model->getMonitored($table);
        return $data->sumMonitored;
}
function get_Role_Name(){
        $data = $this->Model->getRoleName();
        if($data){return $data->role_name;}
}
        function get_dosimeter(){
                $data = $this->Model->SumDosimeters();
        return $data->sum_dosimeter;
}

function get_sectors(){
        $data = $this->Model->SumSectors();
        return $data->sum_sectors;
}
        function get_inst(){
        $data = $this->Model->SumInstitutions();
        return $data->count_inst;
}
        function get_pending_request(){
        $data = $this->Model->getPendingRequest();
        return $data->sum_pending;
}
        function get_dosimeter_field(){
        $data = $this->Model->getDosimeterField();
        return $data->sum_field;
}
```

```
        function get_avail_dos(){
        $data = $this->Model->getDosimeterAvail();
        return $data->sum_avail;
    }
            function get_overdue_dos(){
        $data = $this->Model->GetOverDueDos();
        return $data->sum_overdue;
    }
        function get_dispatched_request(){
        $data = $this->Model->GetDispatched();
        return $data->sum_dispatched;
    }
        public function isAccessValid($ontrol,$method){
            $get_data = $this->Model->getAccess($ontrol,$method);
            if($get_data){
                return true;
            }
            else{
                return false;
            }
    }

}
?>
```

Appendix 5: Type of practices codes

```
<?php
class Sectors extends CI_Controller {
   public function __construct() {
      parent::__construct();
      // if($this->session->userdata('e_mail') == NULL)
      // redirect(base_url());
      $this->make_bread->add('Add Sectors', "management/Sectors", 0);
      $this->breadcrumb = $this->make_bread->output();
                  $this->CI = & get_instance();
   }
    public function mail_check()
 {
   $datauser=$this->Model->getOne('utilisateur',array('UTILISATEUR_ID'=>$this->input-
>post('UTILISATEUR_ID')));
    if($datauser['EMAIL']==$this->input->post('EMAIL'))
    {
     return true;
    }
    if($datauser['EMAIL']!=$this->input->post('EMAIL'))
    {
     $datautilisat=$this->Model->getOne('utilisateur',array('EMAIL'=>$this->input-
>post('EMAIL')));
      if(!empty($datautilisat))
      {
            $this->form_validation->set_message('mail_check', 'Cet email existe déjà');
       return false;
      }
      else
      {
       return true;
      }
    }
```

```
  }
    public function index()
      {
        $this->make_bread->add('Sectors', "management/Sectors", 0);
        $data['breadcrumb'] = $this->make_bread->output();
         $data['title']="Sectors";
        $this->load->view('Sectors_view/Sectors_Add_Views',$data);
     }
    public function add() {
       $this->form_validation->set_rules('sector_name','Sector',
'trim|is_unique[sectors.sector_name]|required');

       if ($this->form_validation->run() == FALSE)
        {
          //form_validation ikigoma inarudu kwenye input form
                $this->make_bread->add('Sectors', "management/Sectors", 0);
        $data['breadcrumb'] = $this->make_bread->output();
         $data['title']="Sectors";
        $this->load->view('Sectors_view/Sectors_Add_Views',$data);
          }
       else
       {

          $data = array(
                  'sector_name'=> $this->input->post('sector_name'),
                  'status'=> $this->input->post('status')
          );
// save input data as a row to the table sectors of the database
      $table='sectors';
   $this->Model->create($table, $data);
   /*print_r($pwd);
   exit();*/
       $data['message']='<div class="alert alert-success text-center">'."New record "." '.$this-
```

```
>input->post('sector_name')." added successfully )".'</div>';
   $this->session->set_flashdata($data);
     redirect(base_url('management/Sectors/listing'));
      }
   }
   public function listing()
   {

    $result=$this->Model->getList('sectors',array());
    $tabledata=array();
    foreach ($result as $key)
    {
          $sector=array();
          $sector[]=$key['sector_name'];
          $sector[]=$key['status'];
          $sector['OPTIONS'] = '<div class="dropdown ">
              <a class="btn btn-primary btn-sm dropdown-toggle" data-
toggle="dropdown">Action
              <span class="caret"></span></a>
              <ul class="dropdown-menu dropdown-menu-left">
                 ';
             $sector['OPTIONS'] .= "<li><a
href='".base_url("management/Sectors/getOne/".$key['sector_id'])."'>Edit</a></li>";
          $sector['OPTIONS'] .= "<li><a hre='#' data-toggle='modal'
              data-target='#mydelete" . $key['sector_id'] . "'><font
color='red'>Delete</font></a></li>";
              $sector['OPTIONS'] .= "  </ul>
            </div>
              <div class='modal fade' id='mydelete" . $key['sector_id'] . "'>
                  <div class='modal-dialog'>
                   <div class='modal-content'>
                  <div class='modal-body'>
                  <h5>Delete  :<b>" . $key['sector_name'] . "</b>?</h5>
```

```
                                    </div>

                                <div class='modal-footer'>
                            <a class='btn btn-danger btn-md' href='" . base_url('management/Sectors/delete/'.$key['sector_id']). "'>Delete</a>
                            <button class='btn btn-primary btn-md' class='close' data-dismiss='modal'>Exit</button>
                                    </div>

                                </div>
                            </div>
                        </div>";


        $tabledata[]=$sector;
        }
          $template = array(
             'table_open' => '<table id="sector_list" class="table table-bordered table-stripped table-hover table-condensed">',
             'table_close' => '</table>'
          );
          $this->table->set_template($template);
          $this->table->set_heading(array('Sector Name ','Sector Status','Options'));
          $data['sector']=$tabledata;
          $data['title']="Sectors";
          $data['breadcrumb'] = $this->breadcrumb;
          $this->load->view('Sectors_view/Sectors_List_View',$data);
    }
function getOne()
    {
        $table="sectors";

       $criteria['sector_id']=$this->uri->segment(4);
```

```
        $data['sector']=$this->Model->getOne($table, $criteria);

        $this->make_bread->add('Sectors', "management/Sectors", 0);
        $data['breadcrumb'] = $this->make_bread->output();
        $data['title']="Sectors";

        $this->load->view('Sectors_view/Sectors_Update_View',$data);

      }
    public function Edit() {
      $this->form_validation->set_rules('sector_name','Sector', 'trim|required');
      //$this->form_validation->set_rules('TELEPHONE',",
'trim|required|callback_tel_check',array('required'=>'Le Numéro de téléphone est obligatoire','is_unique'=>'Le téléphone est unique'));

      $criteria['sector_id']=$this->input->post('sector_id');

      if ($this->form_validation->run() == FALSE)
       {

        //form_validation ikigoma inarudu kwenye update form

        $table="sectors";



        $data['sector']=$this->Model->getOne($table, $criteria);


        $this->make_bread->add('Sectors', "management/Sectors", 0);
        $data['breadcrumb'] = $this->make_bread->output();
        $data['title']="Sectors";
```

```
        $this->load->view('Sectors_view/Sectors_Update_View',$data);

         }

      else
      {


        $data = array(

              'sector_name'=> $this->input->post('sector_name'),
              'status'=> $this->input->post('status')
        );

// save updates on the row of the table sectors of the database

   $table='sectors';

   $this->Model->update($table,$criteria,$data);

   $data['message']='<div class="alert alert-success text-center">'."Record updated successfully )".'</div>';
   $this->session->set_flashdata($data);

   redirect(base_url('management/Sectors/listing'));

      }
   }

function delete()
{
    $table="sectors";
```

```
    $criteres['sector_id']=$this->uri->segment(4);
    $data['rows']= $this->Model->getOne( $table,$criteres);
    $this->Model->delete($table,$criteres);
    $data['message']='<div class="alert alert-success text-center">'."A sector "."
'.$data['rows']['sector_name'] ." was removed successfully".'</div>';
    $this->session->set_flashdata($data);

    redirect(base_url('management/Sectors/listing'));

}

        public function isAccessValid($ontrol,$method){
                        $get_data = $this->Model->getAccess($ontrol,$method);
                        if($get_data){
                                return true;
                        }
                        else{
                                return false;
                        }
        }

        function get_Role_Name(){
                $data = $this->Model->getRoleName();
                if($data){return $data->role_name;}
        }

}
```

Appendix 6: Codes for add and view institutions

```
<?php
 use PhpOffice\PhpSpreadsheet\Spreadsheet;
use PhpOffice\PhpSpreadsheet\Reader\Csv;
use PhpOffice\PhpSpreadsheet\Reader\Xlsx;
use PhpOffice\PhpSpreadsheet\Reader\Xls;
class Institution extends CI_Controller {
    public function __construct() {
        parent::__construct();
        $this->make_bread->add('Add Institution', "management/Institution", 0);
        $this->breadcrumb = $this->make_bread->output();
                    $this->CI = & get_instance();
    }
    public function index()
      {
        $this->make_bread->add('Institution', "management/Institution", 0);
        $data['breadcrumb'] = $this->make_bread->output();
        $data['sectors'] = $this->Model->getList('sectors');
        $data['title']="Institution";
        $this->load->view('Institution_view/Institution_Add_Views',$data);
     }
     public function add() {
        $this->form_validation->set_rules('institution_name','institution_name',
'trim|required|is_unique[institution.institution_name]');
        $this->form_validation->set_rules('mobile_number',  '  mobile_number  ',
'trim|required|is_numeric|is_unique[institution.mobile_number]');

        if ($this->form_validation->run() == FALSE)
          {
        $this->make_bread->add('Institution', "management/Institution", 0);
        $data['breadcrumb'] = $this->make_bread->output();
        $data['institution'] = $this->Model->getList('institution');
        $data['title']="Institution";
```

```
        $this->load->view('Institution_view/Institution_Add_Views',$data);
          }
       else
       {
          $data = array(

          'institution_name'=> $this->input->post('institution_name'),
          //'sector_name'=>$this->input->post('sector_name'),
          'region'=> $this->input->post('region'),
          'city'=> $this->input->post('city'),
          'mobile_number'=> $this->input->post('mobile_number'),
          'descriptions'=> $this->input->post('descriptions')
          //'status_id'=>$this->input->post('status_id')

          );
   $table='institution';
   $this->Model->create($table, $data);
   /*print_r($pwd);
   exit();*/
      $data['message']='<div class="alert alert-success text-center">'."New record added".'
'.$this->input->post('institution_name')."  successfully )".'</div>';
   $this->session->set_flashdata($data);
     redirect(base_url('management/Institution/listing'));
      }
   }
   public function listing()
   {

    $result=$this->Model->getList('institution',array());
    $tabledata=array();
   foreach ($result as $key)
    {
   $sectors=$this->Model->getOne('sectors',array('sector_id'=>$key['sector_id']));
```

```
            $institution=array();
            $institution[]=$key['institution_name'];
           $institution[]=$key['region'];
            $institution[]=$key['city'];
            $institution[]=$key['mobile_number'];
            $institution[]=$key['descriptions'];
   $institution['OPTIONS'] = '<div class="dropdown ">
                <a class="btn btn-primary btn-sm dropdown-toggle" data-
toggle="dropdown">Action
                <span class="caret"></span></a>
                <ul class="dropdown-menu dropdown-menu-left">

   $institution['OPTIONS'] .= "<li><a
href='".base_url("management/Institution/getOne/".$key['institution_id'])."'>Edit</a></li>";
   $institution['OPTIONS'] .= "<li><a hre='#' data-toggle='modal'
                        data-target='#mydelete" . $key['institution_id'] . "'><font
color='red'>Delete</font></a></li>";

   $institution['OPTIONS'] .= "   </ul>
            </div>
                        <div class='modal fade' id='mydelete" . $key['institution_id'] . "'>
                           <div class='modal-dialog'>
                              <div class='modal-content'>
                                 <div class='modal-body'>
                                    <h5>Delete  :<b>" . $key['mobile_number'] . "</b>?</h5>
                                 </div>
                                <div class='modal-footer'>
                                    <a class='btn btn-danger btn-md' href='" .
base_url('management/Institution/delete/'.$key['institution_id']). "'>Delete</a>
                                    <button class='btn btn-primary btn-md' class='close' data-
dismiss='modal'>Exit</button>
                                 </div>
```

```
                        </div>
                    </div>
                </div>";

        $tabledata[]=$institution;
        }
          $template = array(
             'table_open' => '<table id="institution_list" class="table table-bordered table-stripped table-hover table-condensed">',
             'table_close' => '</table>'
          );
          $this->table->set_template($template);
          $this->table->set_heading(array('Institution','Region','City','Mobile Number','Description','Options'));
          $data['institution']=$tabledata;
          $data['title']="Institution";
          $data['breadcrumb'] = $this->breadcrumb;
          $this->load->view('Institution_view/Institution_List_View',$data);
    }

function getOne()
    {
     $table= "institution";

$this->make_bread->add('Institution', "management/Institution", 0);

$data['breadcrumb'] = $this->make_bread->output();

$criteria['institution_id']=$this->uri->segment(4);

$data['institutions'] = $this->Model->getOne('institution',$criteria);

$data['title']="Institution";
```

```
$this->load->view('Institution_view/Institution_Update_View',$data);
        }

    public function Edit() {

      $this->form_validation->set_rules('institution_name','Institution', 'trim|required');

      $criteria['institution_id']=$this->input->post('institution_id');

      if ($this->form_validation->run() == FALSE)
        {
          //form_validation ikigoma inarudu kwenye update form
                $table="institution";
      $data['institutions']=$this->Model->getOne($table, $criteria);
                $this->make_bread->add('institution', "management/Institution", 0);
        $data['breadcrumb'] = $this->make_bread->output();
        $data['title']="Institution";
                $this->load->view('Institution_view/Institution_Update_View',$data);
           }
      else
      {

          $data = array(
          'institution_name'=> $this->input->post('institution_name'),
          'region'=> $this->input->post('region'),
          'city'=>$this->input->post('city'),
          'mobile_number'=>$this->input->post('mobile_number'),
          'descriptions'=>$this->input->post('descriptions')
          );
// save updates on the row of the table dosimeters of the database
      $table='dosimeters';
   $this->Model->update($table,$criteria,$data);
```

```
    $data['message']='<div class="alert alert-success text-center">'."Dosimeter updated successfully ".'</div>';
   $this->session->set_flashdata($data);
     redirect(base_url('management/Dosimeter/listing'));
      }
   }
function delete()
{
    $table="institution";
    $criteria['institution_id']=$this->uri->segment(4);
    $data['rows']= $this->Model->getOne( $table,$criteria);
    $this->Model->delete($table,$criteria);
    $data['message']='<div class="alert alert-success text-center">'."Deleting a User"." ".$data['rows']['institution_name']." ".$data['rows']['mobile_number']." made successfully".'</div>';
    $this->session->set_flashdata($data);

    redirect(base_url('management/Institution/listing'));

}
// import function
   public function import(){
            //file type
      $file_mimes = array('text/x-comma-separated-values', 'text/comma-separated-values', 'application/octet-stream', 'application/vnd.ms-excel', 'application/x-csv', 'text/x-csv', 'text/csv', 'application/csv', 'application/excel', 'application/vnd.msexcel', 'text/plain', 'application/vnd.openxmlformats-officedocument.spreadsheetml.sheet');

      if(isset($_FILES['file']['name']) && in_array($_FILES['file']['type'], $file_mimes)) {

         $arr_file = explode('.', $_FILES['file']['name']); //get file
         $extension = end($arr_file); //get file extension
```

```
// select spreadsheet reader depends on file extension
if('csv' == $extension) {
   $reader = new \PhpOffice\PhpSpreadsheet\Reader\Csv();
} else if ('xlsx'){
   $reader = new \PhpOffice\PhpSpreadsheet\Reader\Xlsx();
} else {
   $reader = new \PhpOffice\PhpSpreadsheet\Reader\Xls();
}
//'Data' Table
$dataList = array();
$dataListArray = array();

$reader->setReadDataOnly(true);

//Get filename
$objPHPExcel = $reader->load($_FILES['file']['tmp_name']);

//Get sheet by name
$worksheet = $objPHPExcel->getSheetByName('Dosimeters');

/*
* Get sheet by index
* Get the second sheet in the workbook
* Note that sheets are indexed from 0
*/
// $spreadsheet->getSheet(1);

/*
* Get current active sheet
*/
//$spreadsheet->getActiveSheet();

$highestRow = $worksheet->getHighestRow(); // e.g. 12
```

```
        $highestColumn = $worksheet->getHighestColumn(); // e.g M'
        $highestColumnIndex =
\PhpOffice\PhpSpreadsheet\Cell\Coordinate:  columnIndexFromString($highestColumn);  //
e.g. 7
        //Ignoring first row (As it contains column name)
        for ($row = 2; $row <= $highestRow; ++$row) {
           //A row selected
           for ($col = 1; $col <= $highestColumnIndex; ++$col) {
              // values till $cityList['1'] till $cityList['last_column_no']
              $dataList[$col]    =    $worksheet->getCellByColumnAndRow($col,    $row)-
>getValue();
              }
              array_push ($dataListArray, $dataList);
              //next row, from top
        }

        if($this->m_import->import($dataListArray) == TRUE){
           // what to do if import successfull
           redirect('/');
        } else {
           // what to do if import failed
           redirect('notok');
        }

     }
  }
              public function isAccessValid($ontrol,$method){
                     $get_data = $this->Model->getAccess($ontrol,$method);
                     if($get_data){
                            return true;
                     }
                     else{
                            return false;
```

```
                    }
        }

        function get_Role_Name(){
                $data = $this->Model->getRoleName();
                if($data){return $data->role_name;}
        }
}
```

Appendix 7: Poster Presentation

Output 2: Poster Presentation

Web-based Personal Dose Management System for Data Recording on Dosimeter Usage

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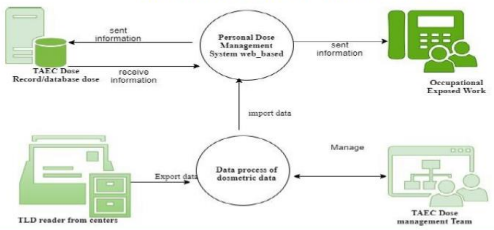
INTRODUCTION

Due to rapid technological advancements, many industries and individuals must now have internet access to all resources. The Tanzanian Atomic Energy Commission (TAEC) required a Personal Dose Management System to collect and store data from people wearing dosimeters in radioactive areas. Radiation management monitors each worker's exposure. Keeping doses low minimizes the likelihood of deterministic effects like cancer formation and radiation-induced skin burns. Personal dosimetry is essential for determining acceptable and unacceptable radiation exposure levels. According to the as low as reasonably achievable principle, this technology must be used to achieve and demonstrate adequate radiation protection. Dosimetry measures how much radiation a material or biological organism has absorbed. Dosimeters include film badges, thermoluminescent, electronic personal, and MOSFET dosimeters. Workers in radiation labs must wear dosimeters to record their radiation exposure accurately. Each worker wears a dosimeter on the chest on the left-hand side where the heart is located to know the amount of radiation reaching the heart. Reading individual records obtained through dosimeters helps in knowing the level of exposure each worker encounters. As a result, the proposed system will assist workers and administrators in tracking when dosimeters are dispatched and when they must be returned to TAEC. The system will also print individual reports from different locations and retrieve data on how much radiation they received at each location.

PROBLEM STATEMENT

Tanzania Atomic Energy Commission is finding it difficult to track and have smooth issuing and returning dosimeter records because the current tracking works manually. Dues to human errors, sometimes the records are not taken accurately. The users of the dosimeters have to be reminded by officers using phone calls or SMS, and the schedules are not always accurately followed. Sometimes, a user can be overdosed by radiation without knowing this since records have not been kept or returned, leading to inaccurate records. Hence, it proves the necessity to develop the proposed system further to fill the identified gap

ARCHITECTURE OF THE SYSTEM



OBJECTIVES

MAIN OBJECTIVE

The main objective of this study is to develop a system that can manage data recorded by dosimeters at the Tanzania Atomic Energy Commission.

SPECIFIC OBJECTIVES

i. To identify and establish requirements for a Personal Dose Monitoring System.
ii. To design and develop the Personal Dose Management system.
iii. To validate and implement the developed Personal Dose Management system.

CONCLUSION

This platform will manage data from dosimeters in the health, mining, agriculture, and other domains that deal with radiation sources. The developed system was presented in the study, followed by system testing. The results show that using the suggested system will increase efficiency while minimizing manual work, as the TAEC has recently increased staff in the department of radioactive sources. Employees exposed to radiation are constantly monitored. The designed system allows the administrator to enter information on sectors, institutions, and dosimeters, as well as register occupational employees who have been exposed to radiation. With a system signature key and created encryption standards like Message Direct (MD-5), the system administrator's role of ensuring compatibility, performance, and system maintenance is simplified.