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Water Management Plant Information System

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***Abstract**: Due to the poor water management issue that faced by Sawit Kinabalu Sdn Bhd, a proposed water management system was requested to be developed in this project to overcome the challenges such as inefficient of working performance. The proposed system should be accessible by the personnel of Sawit Kinabalu Sdn Bhd and it can manage the data of operating units and water management. The method used to develop the system is agile scrum methodology by using the Laravel framework. Laravel is PHP-based framework used to develop large-scale application system. The proposed system is expected to help the clients by lower the complexity of workflow which also increase the productivity and efficiency of water management workflow. For the future enhancement, it is expected to be integrated with IOT technical devices to record and manage the data systematically and automatically.*

***Keywords**: Water Management System, water management, Laravel, Agile Scrum Methodology, Sawit Kinabalu Sdn Bhd.*

1. Introduction

Water consumption has increased annually based on research published by the Statista Research Department.For example, Statista Research Department [7] published the results that display that the metered water consumed by Malaysians has almost 7.17 billion liters which are about 1894113240 gallons per day. For instance, Haliza [1] states the leading causes of the water shortage problem are rising demand, an increase in the number of citizens, and poor river basin management.This system, termed the Water Management Plant Information System (Domestic), is being suggested by the entity called Sawit Kinabalu Sdn Bhd, which is based in Kota Kinabalu, Sabah, Malaysia, to manage and present the water management data recorded in various estates and mills that possessed by the organization. It is a web-based application that is designed to reduce the burdens of Sawit Kinabalu Sdn Bhd during the water management processes of their different estates or mills.

Moreovere, this proposed water management system is constructed for the water data management recorded from different estates and mills possessed by the client company. Therefore, it can greatly reduce the complexity when managing the water management system of Sawit Kinabalu Sdn Bhd. Furthermore, the Operating Unit Manager can also view the data information from different estates or mills through the same water management system as well as discover the problem faster, such

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as the manager can discover the water quality of an estate or mill once the data recorded exceeded the safety level of chemical existed in the water resource.

2. Related Work

A literature review is conducted before the construction of the proposed system. A lot of resources were taken as the references of conducting the literature review of this project, such as journal papers, thesis, existing systems that familiar with the proposed water management system. Especially the three existing systems chosen for making comparison with the proposed system were extremely contributed in the later improvement of the proposed water management system.

2.1 Web Application

A web application is a software application that is implemented on the World Wide Web. It is accessed by several web browsers such as Google Chrome, Mozilla Firefox, Microsoft Edge, and so on. There are a variety of ways in which web applications can be developed and deployed. Dissanayake and Dias [4] state that developers can also use several different programming languages to create a web application. Popular languages include C++, Java, C#, Visual Basic, PHP, and JavaScript. Most modern web applications are written using a server-side scripting language such as PHP or ASP.NET.

2.2 Laravel Framework

The Laravel framework is a PHP-based web application development platform. Laaziri et al. [3] state that it offers an expressive, elegant syntax and a powerful routing system. Refsnes et al. [2] state that Laravel is an open-source PHP web framework that was released in 2011 by Taylor Otwell. It has been used to create a wide range of applications, including social networking websites and online stores. The framework has been criticized for being difficult to learn and for lacking documentation.

2.3 Comparison with the Existing System

In this section will make a comparison on the functionality between the selected existing water management with the proposed system. Table 1 below presents the results of comparison among the three selected systems with the proposed water management system.

Table 1: Comparison Between 3 Existing Systems and Proposed System

Feature/ System	Water Management Application	WMS Mobile Application	Wamasys	Proposed System
Register and Login	√	√	√	√
Admin panel	√	√	√	√
Record rainfall data	×	×	×	√
Record water usage	√	×	√	√
Monitor water quality	√	√	×	√
Monitor wastewater	√	×	×	√
Payment module	×	×	√	×

From the comparison table displayed at the Table 1 above, the proposed water management system is obviously beneficial and it has more functional than the other three selected existing system

as well as excluding the payment module that charging users for additional features provided by the system.

3. Methodology/Framework

First and foremost, Peek [5] states that agile scrum models are a combination set of practices and methods used to manage software development projects. Scrum is a lightweight framework designed for small, self-organizing teams to work on complex projects. Using scrum enables the team to work in short sprints and use an iterative approach to development. It is beneficial for a project team to complete their tasks systematically as well as improve the quality of the final output. During the initial phase of this project, an interview among the stakeholders and developer was conducted before the project is starting to develop. Including the executive general manager, Mr. Nazlan Mohamad, and Mrs. Norfai'eza Zainuren from MZR Global Sdn. Bhd, accompanied with the representative from Sawit Kinabalu Sdn. Bhd, Mrs. Julianah Sagap. These interviews will be conducted in every sprint session that mentioned inside the agile scrum methodology model. There are five phases in the project development processes, such sprint initiation, sprint planning, implementation, reviewing, and releasing. The agile scrum model is shown in Figure 1 below.

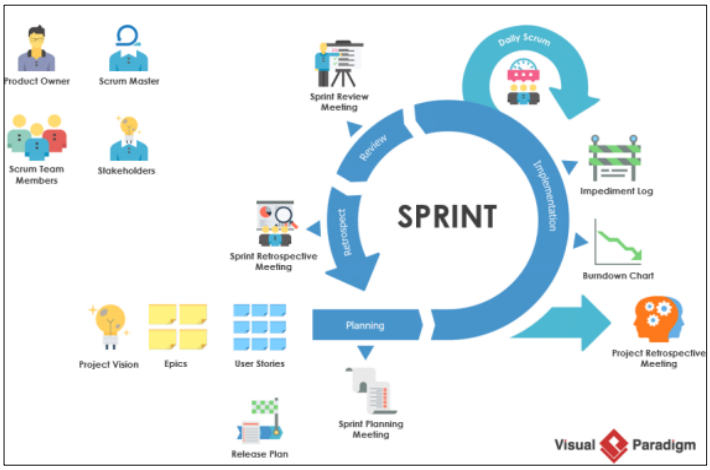

Figure 1: Agile Scrum Model [8]

3.1 System Development Workflow

In this section, there is a total of five phases including the agile scrum methodology model. Table 2 displays the tasks and output during the respective phases of project development.

Table 2: Project Development along with Tasks and Output

Phase	Tasks	Output
Initiation	● Conduct interviews with the stakeholders in this project. ● Having a draft or blueprint about the proposed water management system requested by Sawit Kinabalu Sdn Bhd. ● Create a to-do list during the project planning.	● Product sprint backlog. ● Receiving of excel forms that contains water management records from Sawit Kinabalu Sdn. Bhd. ● Draft or blueprint of the proposed water management system. ● Business workflow diagram illustrated based on the excel form given by Sawit Kinabalu Sdn. Bhd.
Planning	● Identify the scope or tasks needed to be completed before the next sprint meeting.	● Records of planning activities inside an e-log book.

Phase	Tasks	Output
	● Breaking a big project into small timed-boxed iterations. ● Make a priority listing of the modules depends on the excel forms given.	● Selection of methodology in project development. ● Gantt Chart constructed for scheduling tasks. ● Use case diagram based on the requirements and also the excel forms given by Sawit Kinabalu Sdn. Bhd. ● Class diagram of the database construction for the proposed water management system.
Daily Sprint	● Hold sprint meeting at the scheduled time. ● Complete the tasks given or planned during the previous sprint meeting.	● Records for upcoming tasks before next sprint. ● Achieve the goal assigned or planned during the sprint.
Sprint Review	● Demonstrate the system configuration progress to the client. ● Identify the next objective or tasks to be completed in the next sprint.	● RESIP UTHM Meeting is held every two weeks. ● Presents the modified proposed water management system to Mrs. Norfai'eza Zainuren and Mrs. Julianah Sagap. ● Modified product backlog.
Sprint Retrospective	● Learn from the previous sprint. ● Identifies the flaws and rectifies them.	● Determines the parts or modules that required to be modified or enhanced. ● Listing of motions for the next sprint review meeting.

3.2 Hardware Requirements

Table 3 below presents the hardware requirements required in the project development processes.

Table 3: Hardware Requirements Description

Hardware	Description
Laptop	It is the core hardware used to develop the proposed water management system. Every software application needs to be implemented and installed inside the laptop devices.
SSD	It is hardware to store important data such as the source code of the proposed system inside the laptop devices when the system development and configuration is started.
RAM	It is the hardware that ensures the efficiency and productivity of the project development processes.
Wi-Fi Router	It is an important device to ensure a stable internet connection. It can also ensure the live streaming of the proposed system is successful when the developer is configuring the system.

3.3 Software Requirements

Table 3.3.1 below presents the software requirements required in the project development processes.

Table 4: Software Requirements Description

Software	Description
Visual Studio Code	It is the core software used to develop the programming of the proposed water management system
XAMPP	It is software to manage the local environment database server using MySQL and PHP.
GitLab	It is the software that ensures productivity and tracks the progress of a developer.
Author System	It is a web application deployed by UTHM. It provides a feature named e-log book which is used to record the tasks and planning of a sprint meeting.

4. System Analysis and Design

In Simplilearn [6] states that requirements analysis is also known as requirements engineering, it is the process of identifying, quantifying, and documenting the specific requirements that a product or service must meet to be successfully implemented. The functional requirement analysis is utilized to describe the functionalities or modules developed by the system developer which are included inside the proposed water management system in this project.

4.1 Business Workflow

Business workflow portrays the stages that make up a corporate work handle and depicts how these stages can be completed and mechanized using a set of procedural rules. It is additionally advantageous in guaranteeing those vital assignments are carried out precisely each time. A stakeholder from MZR Global Sdn. Bhd, Mrs. Norfai'eza Zainuren was giving her guidance upon the completion of business workflow diagram for the proposed water management system. Figure 2 below depict the business workflow of the proposed water management system.

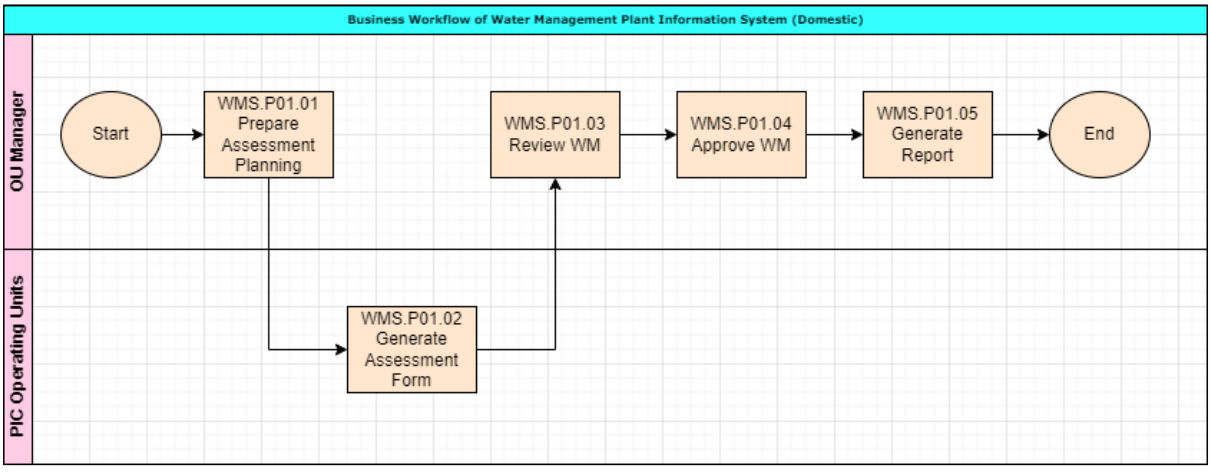

Figure 2: Business Workflow of Proposed WMS

4.1 Functional Requirements

The functional requirement analysis is utilized to depict the functionalities or modules created by the system developer which are included inside the proposed water management system in this project. The requirements below are requested by Mrs. Julianah Sagap, the person who in charge of

this project Table 5 below displays the functional requirements that must be existed inside the features provided by the proposed water management system.

Table 5: Functional Requirements in Proposed System

Module	Description
Register	It is the module for unregistered users to register their user accounts to access the Water Management Plant Information System.
Login/Logout	On this module, the users are allowed to log in or sign out from their accessed and authenticated user accounts.
Users Management	This is the module to manage the user accounts that are registered and authenticated inside the Water Management Plant Information System.
Roles Management	This is the module used to create, edit, show, or delete the role of user accounts inside the system, different roles have various accessibility on the activity control. For example, the Operating Unit Manager has permission to control all the activity inside the system, such as adding a new user.
Forms	It is the module that allows the clerk and operating unit manager users of Sawit Kinabalu Sdn Bhd to create, edit, show, or delete a new assessment form for making documentation of data to be displayed in the report module.
Manage Events	It is the module to create, edit, show, and delete the events that are organized or planned to participate in by Sawit Kinabalu Sdn Bhd.
Report	This is the module that displays the results in tabular form depends on the data entered in the assessment forms by the clerk of Sawit Kinabalu Sdn Bhd. Besides, the clerk and operating unit manager users are able print and download the results out as PDF file format.

4.2 Non-functional Requirements

The non-functional requirement analysis is utilized to analyze the specifications of the Water Management Plant Information System (WMPIS) which do not directly affect the functionalities of the proposed system.The requirements below are also requested by Mrs. Julianah Sagap, the person who in charge of this project from Sawit Kinabalu Sdn. Bhd. Table 6 below presents the non-functional requirements that existed inside the proposed water management system.

Table 6: Non-Functional Requirements

Specifications	Description
Security	● Only the personnel of Sawit Kinabalu can access the system. ● The system can only be accessed by authenticated users with validated user information, such as email addresses and passwords.
Availability	● The system can be accessed at any time and anywhere with a stable internet connection.

Specifications	Description
Compatibility	● The system is able to support different versions of operating systems.
Usability	● The system provides a user-friendly interface to the personnel of Sawit Kinabalu Sdn Bhd. ● The system has a lower learning curve compared to the current water management workflow they used.
Operational	● The database of the system provides CRUD operations. ● The system can be run on most of the current web browsers.

4.3 Use Case Diagram

There are two actors involved in the diagram, which are the operating unit manager and the clerk of Sawit Kinabalu Sdn Bhd. There is a total of 8 modules or functionalities existed in the design of the proposed water management system.Figure 2 below displays the use case diagram of the proposed Water Management Plant Information System.

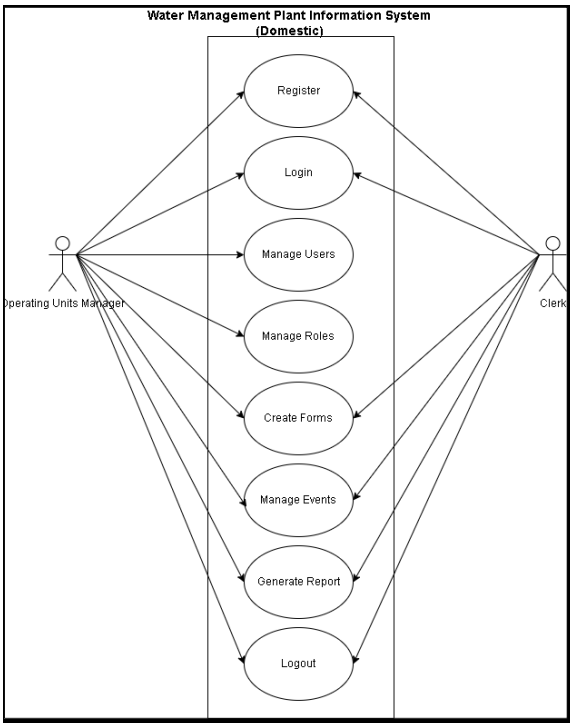

Figure 3: Use Case Diagram of WMPIS

4.4 System Design Diagram

The general system architecture is a field of study that focuses on the design and implementation of computer systems. It encompasses a broad range of topics, from the design of individual components and subsystems to the overall organization and management structure of a large-scale system. Figure 3 below presents the general system architecture design diagram of Water Management Plant Information System.

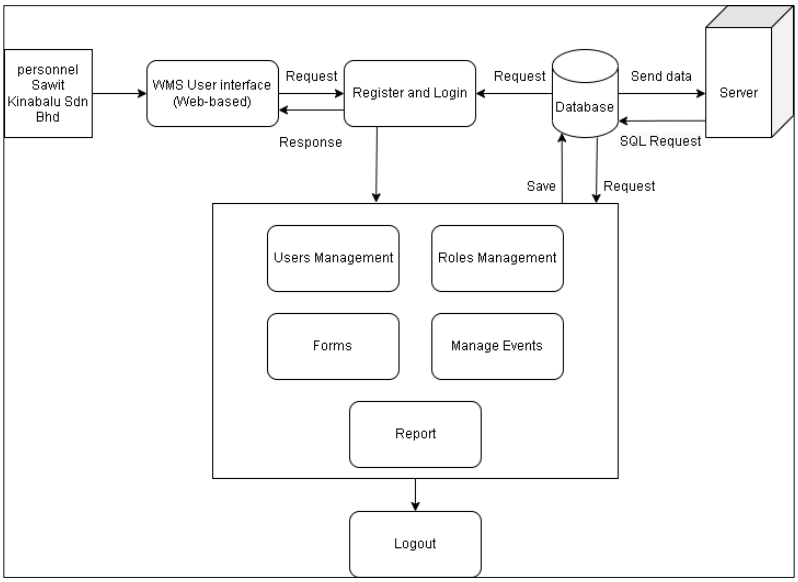

Figure 4: System Architecture Design Diagram of WMPIS

4.5 Class Diagram

A class diagram is a visual representation of the relationships between classes and their members in an object-oriented program. The diagram shows the inheritance hierarchy of classes and their methods, fields, and properties. The purpose of a class diagram is to document the architecture and design of an application. Figure 4 below illustrated the class diagram of the proposed water management system.

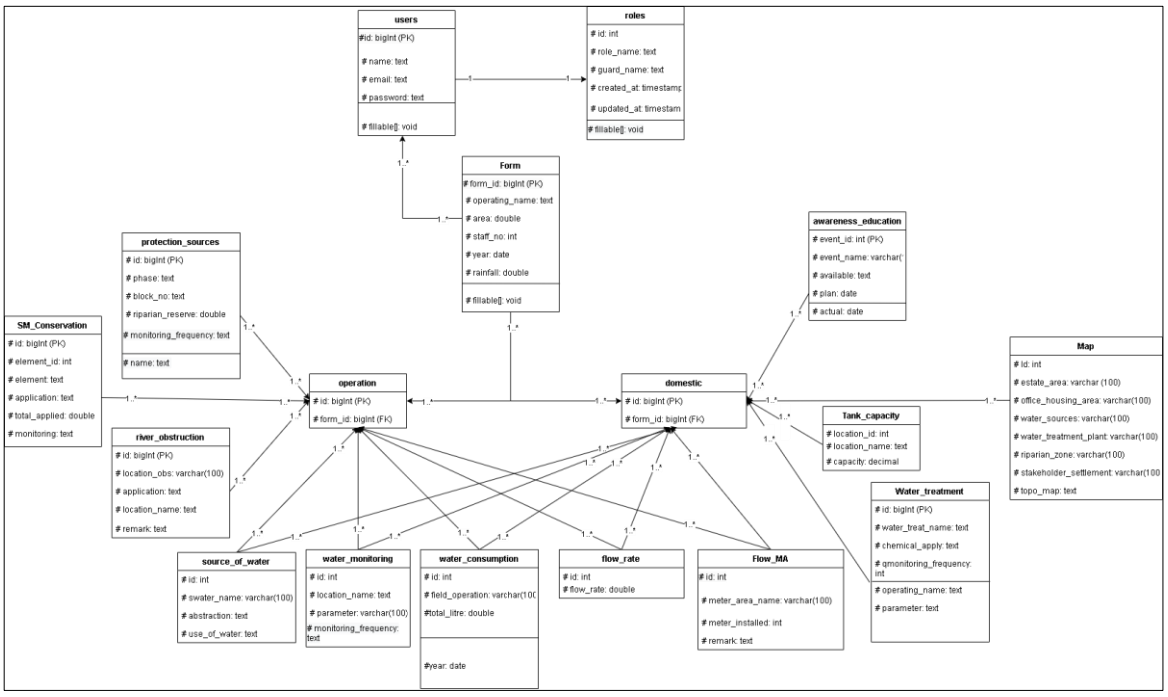

Figure 5: Class Diagram of WMPIS

4.6 Results and Discussion

In this section, it will be discussed about the test plan as well as the constructed user interface for the proposed water management system. In addition, Mrs. Julianah Sagap and Mrs. Norfai'eza

Zainuren were involving themselves for giving advice and guidance during the testing phases of the developed water management system. Table 7 below demonstrates the test category whereas Table 8 presents the test plan for the proposed water management system.

Table 7: Test Category for Proposed System

Test Category	Description
1	Test function for operating unit manager
2	Test function for clerk

Table 8: Test Plan for Proposed System

Module	Test Category	Expected Result	Actual Result
Register	1	Manager can register an user account by using appropriate email and password.	Pass
	2	Clerk can register an user account by using appropriate email and password.	Pass
Log In	1	Manager can sign in user account by using validated email and password.	Pass
	2	Clerk can sign in user account by using validated email and password.	Pass
Log Out	1	Manager can log out from the system.	Pass
	2	Clerk can log out from the system.	Pass
Users Management	1	Manager can create, edit, view, and delete the user accounts registered inside the system.	Pass
Roles Management	1	Manager can create, edit, view, and delete the roles assigned in different user accounts inside the system.	Pass
Forms	1	Manager can create, view, edit, and delete the form data.	Pass

Module	Test Category	Expected Result	Actual Result
	2	Clerk can create, view, edit, and delete the form data.	Pass
Manage Events	1	Manager can create, view, edit, and delete the event data.	Pass
	2	Clerk can create, view, edit, and delete the event data.	Pass
Report	1	Manager can view, edit, and delete the results and generate a report in PDF file format.	Pass
	2	Clerk can view, edit, and delete the results and generate a report in PDF file format.	Pass

4.7 User Interface

UI is an abbreviation of the term user interface, it is the interface that decides how clients will be associated with it as well as how the results or data is being presented to the users at the interfaces of the system. Figure 6 to Figure 15 displays the user interfaces of different modules provided by the proposed water management system in this project.

Figure 6 displays the index of the proposed water management system, it is the first page that the users meet once they access the proposed water management system.

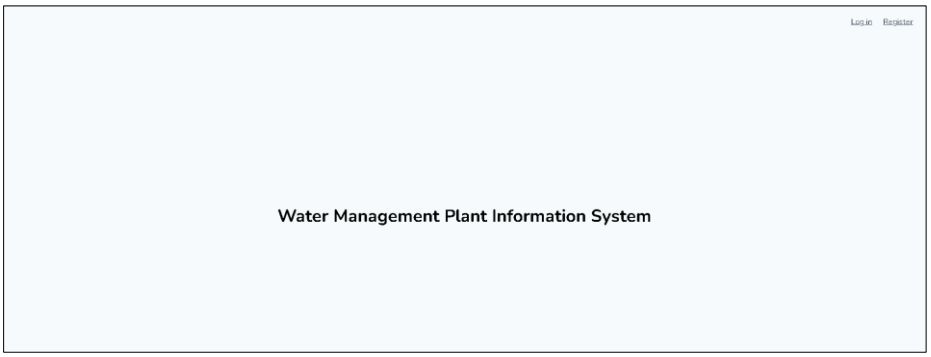

Figure 6: Index Page

Figure 7 displays the login module of the proposed water management system, the operating unit manager users and the clerk users must enter the respective validated email and password to access their user accounts.

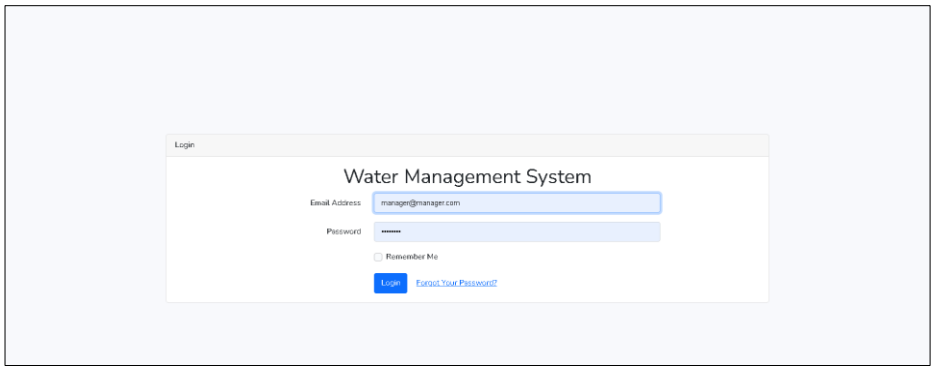

Figure 7: Login Page

Figure 8 presents the dashboard or home page of the proposed water management system, once the operating unit manager users and the clerk users successfully accessed their user accounts.

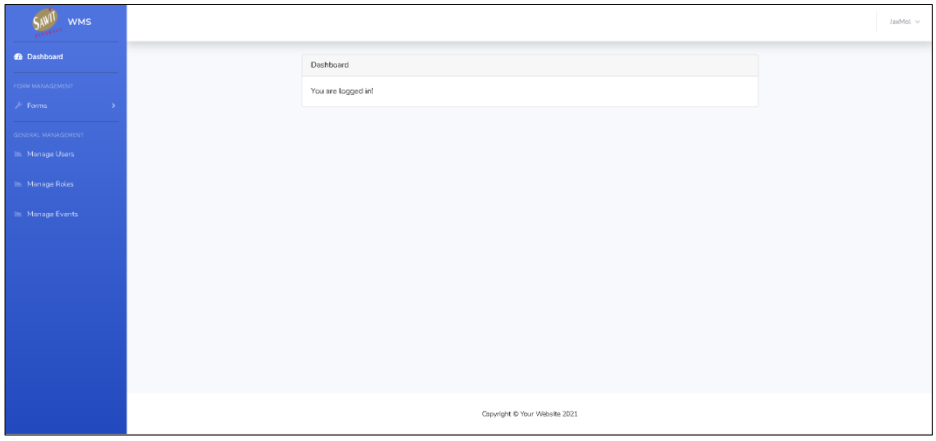

Figure 8: Dashboard Page

Figure 9 is the users management index page of the proposed water management system, the manager users are able to add new users, edit user information, or even delete the existing user accounts from the proposed management system.

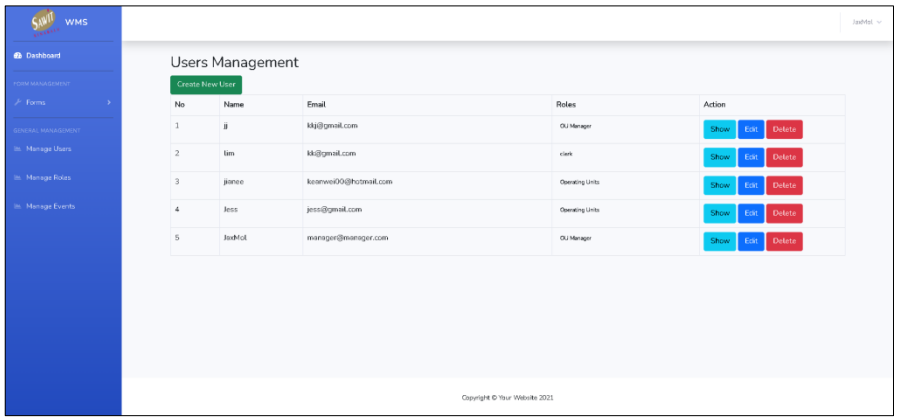

Figure 9: Users Management Page

Figure 10 is the roles management index page of the proposed water management system, the manager users are able to add new roles, edit roles permission on the modules provided by the management system, or even delete the existing roles from the system.

Figure 10: Role Management Page

Figure 11 displays the index page of the "Manage Events" module of the proposed water management system, the manager and clerk users are able to add new events, edit events-related information, or delete the records of event data from the system.

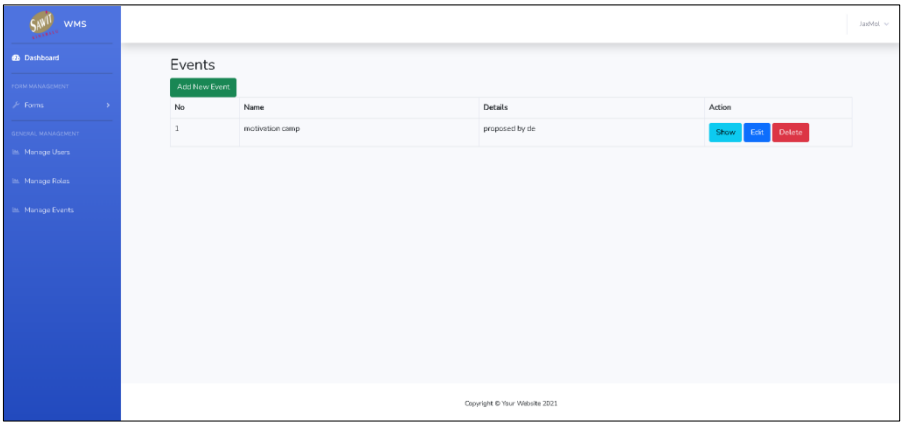

Figure 11: Manage Events Page

Figure 12 displays the index page of the Forms module of the proposed water management system, the manager and clerk users are able to add new assessment form data or record that related with the sources of water from different operating units, water quality monitoring records or results, location of the operating units and so on. They can manage the data from the mill possessed by Sawit Kinabalu Sdn. Bhd in this module.The records of the assessment form will be displayed in a table at the index page in Figure 18.

Figure 12: Forms Page (Mill Forms)

Figure 13 displays the index page of the Forms module of the proposed water management system, the manager and clerk users are able to add new assessment form data or record that related with the sources of water from different operating units, total flow meter installed, pumping rate of water in different water sources and so on. They can manage the data from the estates possessed by Sawit Kinabalu Sdn. Bhd in this module.The records of the assessment form will be displayed in a table at the index page in Figure 19.

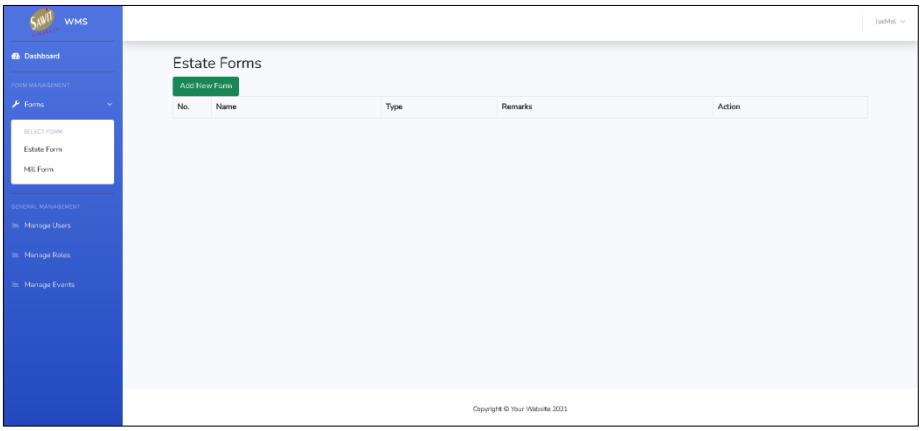

Figure 13: Forms Page (Estate Forms)

Figure 14 shows the create estate form page in the Forms module, the users need to enter the respective data or values to store the water-related information inside the proposed water management system.

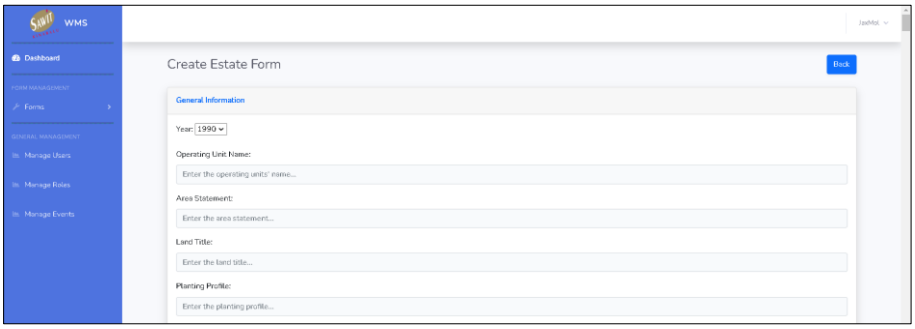

Figure 14: Create Forms page (Estate Forms)

Figure 15 presents the login module of the proposed water management system. It exists as the drop down option below the registered username, the users will be logged out from their current user accounts once they click the logout option and confirm to logout.

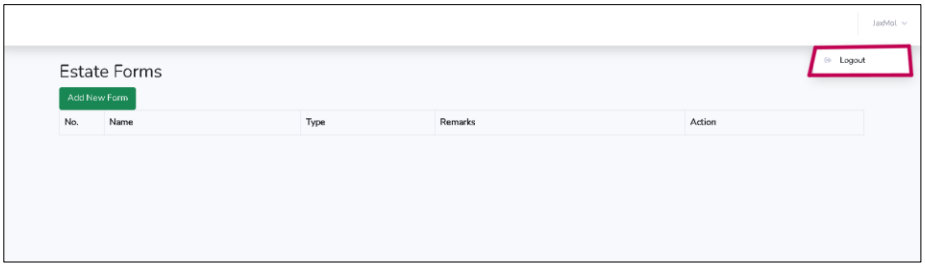

Figure 15: Logout Module

5. Conclusion

In conclusion, this proposed water management system is developed to reduce the complexity of water management workflow as well as increase the working efficiency of Sawit Kinabalu Sdn Bhd. For the future development or enhancement of the proposed system, it is recommended to integrate or incorporate with other technologies, such as Internet of Things (IoT), thus the proposed Water Management Plant Information System (Domestic) is able to real-time record, compute, and manage the water management-related data once the system is linked and cooperated with IOT devices. For example, installing a smart water meter would greatly improve the performance of the proposed system as well as controlling their water usage more efficiently.

Acknowledgment

Firstly, I would like to express my deepest appreciation to MZR Global Sdn. Bhd for providing technical support and suggestions through each stage of the project. Moreover, I would like to thanks and appreciate my client company Sawit Kinabalu, Sdn. Bhd for giving me this golden opportunity to involve myself in this project development. Then, I would also like to thank my supervisor, Prof. Madya Dr. Shahreen Binti Kasim for her guidance and support throughout the whole duration of the project. In addition, I would like to thank my family for supporting me throughout this process and allowing me to pursue my passions, without their support and encouragement, I would never be able to carry out my research projects to the best of my ability.

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