LIGHTHOUSE MAINTENANCE MANAGEMENT MOBILE APPS SYSTEM

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Abstract: Lighthouse is a tower with a strong light which gives navigators a continuous signal. There are about six lighthouses under the responsibility of the Central Region Marine Department of Malaysia. These lighthouses experienced severe construction defects and internal defects. Predictive maintenance, therefore, is performed manually to preserve the lighthouses. Lighthouse Maintenance Management Mobile Apps System (LMMS) is an Android mobile application developed for the Assistant Engineer, Technician, Marine Officer and Division Head of the Central Region Marine Department of Malaysia, responsible for the maintenance of lighthouses. Currently, the Central Region's Marine Department of Malaysia lacks a computerised maintenance management system for the lighthouses, especially to manage maintenance schedules, work orders and maintenance-related records. In addition, the technician still uses a manual guide for troubleshooting tools and spare parts. Thus, LMMS was developed to solve these problems as a fully functioning mobile application by designing and developing a system for lighthouse maintenance management according to user needs. The methodology used to develop this mobile application is agile. The LMMS provides complete features for scheduling maintenance, orders for maintenance work, records related to maintenance, a list of tools and spare parts, and management of lighthouse information. The result shows that LMMS contributes to ease of use by using the mobile platform, quick and simple modules, systematic storage of historical records, efficient workload distribution, rapid reporting, updated list of tools and spare parts, and providing the latest information on the lighthouses. Deploying LMMS helps the Central Region Marine Department of Malaysia manage and maintain the lighthouses more effectively.

Keywords: Lighthouse, Maintenance, Mobile, Application, Marine.

Introduction

Lighthouse is a powerful light tower which offers navigators a continuous or intermittent signal. The lighthouse's two main functions are to serve as a navigational aid and warn boats of dangerous neighbourhoods (Leeds, 2017). Twelve lighthouses in Malaysia currently operate under the supervision of Malaysia's Marine Department or 'Jabatan Laut Malaysia' (JLM). Six of the lighthouses are under the responsibility of Malaysia's Central Region Marine Department. The six lighthouses are One Fathom Bank Lighthouse, Kuala Selangor Lighthouse, Cape Rachado Lighthouse, Pulau Undan Lighthouse, Bukit Jugra Lighthouse, and Pulau Angsa Lighthouse (Jabatan Laut Malaysia, 2020).

Many lighthouse authors and government agencies have focused on lighthouse maintenance from the early 1990s to the present (Leeds, 2017). Lighthouse preservation efforts are supported by organisations such as the International Association for Preservation Technology (APT) and the National Park Service (NPS), which address maintenance, preservation, and repair. Following that, a trained professional was assigned to keep an eye on the structure's condition and perform the daily maintenance and maintenance that a working lighthouse requires.

A maintenance management system is a system that was designed to support maintenance repairs and workflows (Campbell & Picknell, 2015). It also prevents resource

waste and downtime caused by malfunctioning equipment (Arslankaya & Atay, 2015). Furthermore, computer-based support is critical in the proactive maintenance management of world-class facilities (Wienker *et al.,* 2016). As a result, using a computerised maintenance management system effectively as a tool can help with maintenance management. Last, complex processes can be achieved with world-class maintenance management using computerised maintenance system software.

This system is a lighthouse maintenance management app for mobile devices. Currently, the Marine Department of Malaysia's Central Region performs lighthouse maintenance manually, called predictive maintenance. As a result, a mobile maintenance management system is being developed by Malaysia's Central Region Marine Department to improve lighthouse maintenance. Furthermore, mobile apps are rapidly gaining popularity due to their convenience and flexibility (Wienker *et al.,* 2016).

This application is called Lighthouse Maintenance Management Mobile Apps System (LMMS). LMMS is mainly geared towards the management of lighthouse maintenance. Additionally, this mobile application is intended for Assistant Engineers, Technicians, Marine Officers and the Head of Division of Malaysia's Central Region Marine Department, who are responsible for lighthouse maintenance. The user can manage lighthouse maintenance operations with this app anywhere and anytime. LMMS is used to manage maintenance schedules, efficiently manage maintenance work orders, maintain maintenance-related records, maintain maintenance tool and spare parts lists, manage lighthouse information, and access the Malaysia Marine Department website.

Materials and Methods

Agile Methodology

This Lighthouse Maintenance Management Mobile Apps System (LMMS) used an agile development methodology. Figure 1 shows the agile software development. Agile methodology is an iterative and incremental software development method focused on rapidly delivering an application in complete functional components (Peroni, 2017). All the time is "time-boxed" into phases called "sprints" rather than creating tasks and schedules. Each sprint is planned at the beginning of the sprint, where each of them has a defined duration with a list of deliverables running. When deliverables are prioritised, the customer determines the business value. All planned works are reprioritised and the information is used for future sprint planning if all planned sprint work is not complete. Besides, the customer and project team review and evaluate the work once it is finished through daily construction and end-of-sprint demonstrations. By the end of this project, full documentation and system development were completed. Therefore, the agile approach was suitable for this project. The following are the reasons why the agile approach was suitable for this project:-

i.   A well-written compact program was produced which has fewer errors.

ii. The total development time of the whole project is reduced by the agile method.

iii. After each iteration, the customer representative obtains the idea of updated software products. Therefore, it is easy for the customer representative to change any requirements.

Planning, designing, developing, and testing were the four phases followed according to agile methodology. The planning phase began with selecting a project title and gathering analysis requirements such as a problem statement, scope, objectives, and literature review. The designing phase was then followed by the design of the system and content requirements. Functional and non-functional requirements, as well as a use case diagram, activity diagram, and sequence diagram, were included in the system requirements. The design of content requirements, on the other hand, includes the database design and LMMS interface design.

The development phase was completed by creating and implementing the LMMS prototype. Finally, the testing phase was completed, with the prototype being tested and the reinforcement being reviewed. As a result, all four phases were completed iteratively and with frequent direction from the user, making it more user-focused. Not only that, but the user has the opportunity to see the work in progress early on, allowing them to make decisions and changes as the project progresses.
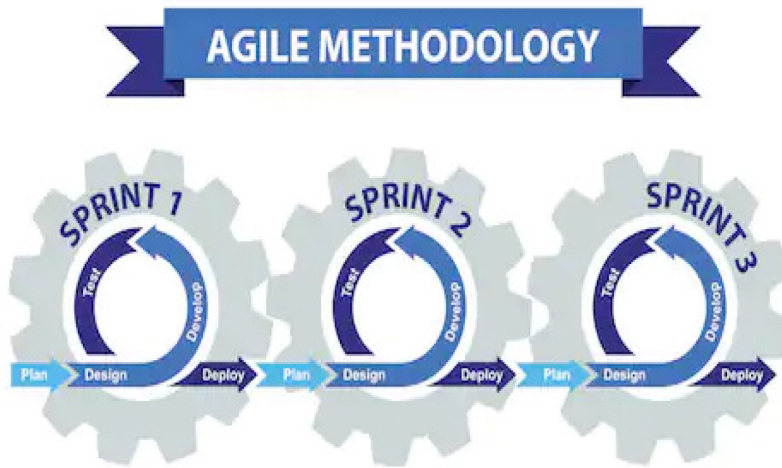

Figure 1: Agile Software Development
Source: https://www.shutterstock.com/search/agile+development

System Requirements

Functional Requirements

Functional requirements define a function of a system or its component which specifies the behaviour between inputs and outputs. Table 1 shows the functional requirements for LMMS.

Table 1: Functional Requirements for LMMS

Functional Requirements
Manage maintenance schedule module
Requirement 1 - The mobile application shall provide the assistant engineer, marine officer and head of the division to manage the maintenance schedule.
Manage maintenance task module
Requirement 2 - The mobile application shall allow the assistant engineer and technician to manage the maintenance task.
View maintenance records module
Requirement 3 - The mobile application shall provide the assistant engineer to view maintenance records.
Manage list of tools and spare parts module
Requirement 4 - The mobile application shall provide the assistant engineer with the ability to manage the troubleshooting tools and spare parts list.

Manage lighthouse information module

Requirement 5 - The mobile application should provide the assistant engineer to manage the lighthouse information.

View marine department website module

Requirement 6 - The mobile application should provide the assistant engineer, marine officer, and head of the division to view the marine department website.

Non-functional Requirements

The primary roles of non-functional requirements are for system performance assessment and verification. The following are the non-functional requirements for LMMS.

Performance

The mobile application response time for every instruction the user conducted must not exceed a minimum of 2 seconds.

Security

The subsystem supplies an optimum level of security and integrity of the data held by this mobile application. Besides, only authorised personnel can access this mobile application and only users with valid username and password can log in to view the user's page.

Availability

This mobile application is available 24 hours, 7 days a week. Also, in the occurrence of any major system malfunctioning, the mobile application is available in 1 to 2 working days so that the maintenance process is not severely affected.

Results and Discussion

Use Case Diagram

Using a case diagram is a method of research to demonstrate how the system will work. The use case model comprises actors and uses cases that are interconnected. Figure 2 shows the Use Case Diagram for LMMS. This diagram has four actors: assistant engineer, technician, marine officer and head of the division. The Use Case Diagram contains six modules: managed maintenance schedule, maintenance task, view maintenance records, manage the list of spare parts and tools, manage lighthouse information, and lastly view marine department website. All six modules were interpreted based on the functional requirements.
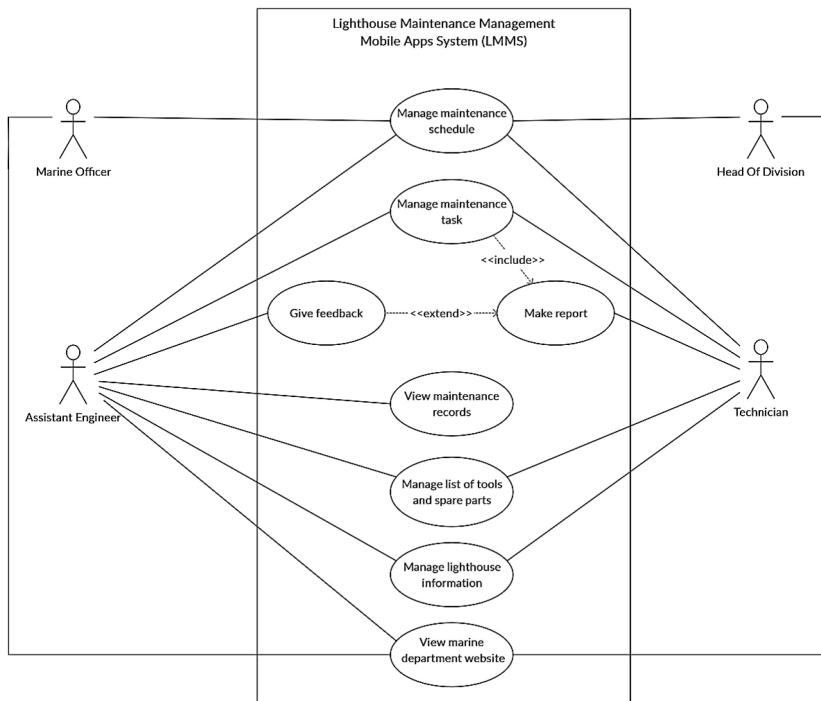
Figure 2: Use Case Diagram for LMMS

Hierarchy Menu

Figure 3 shows the LMMS System Hierarchical Menu. The user can access the Dashboard from the Login page. After logging into respective accounts, users can access Maintenance Schedule, Maintenance Task, Maintenance Record, Spare Parts and Tools, Lighthouse Information, and Website from the Dashboard. The user can go to Upload Schedule and View Schedule Status from the Maintenance Schedule. The user can access Maintenance Records, Inspection Records, and Graph from the Maintenance Record.
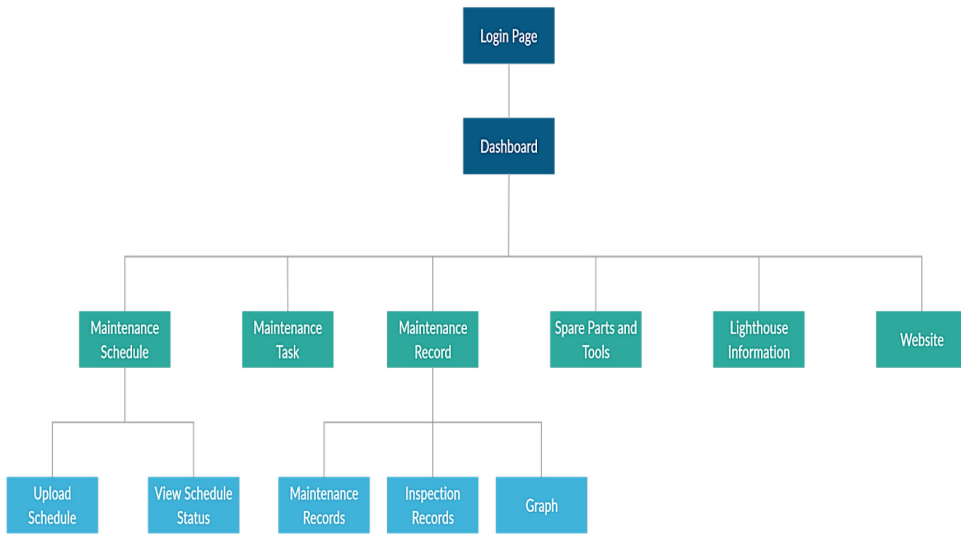
Figure 3: System Hierarchical Menu for LMMS

System Development

Login Page

Figure 4 shows the Login Page for LMMS. The user must enter the given email and password to log into the respective account successfully. This login page allows the users to gain access to LMMS.
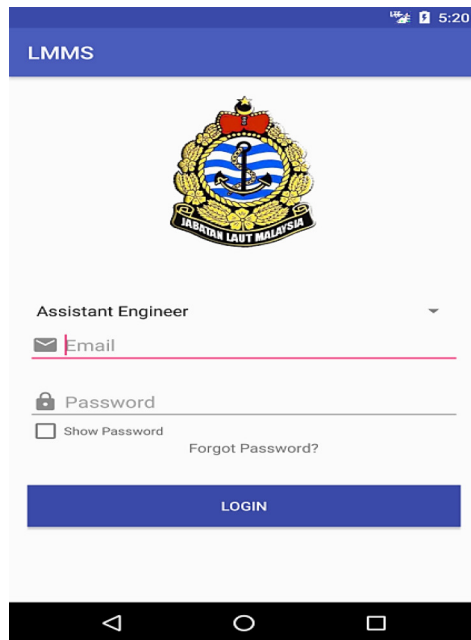
Figure 4: Login Page for LMMS

Dashboard Page

Figure 5 shows the dashboard for the assistant engineer and technician, while Figure 6 shows the dashboard for the marine officer and head of the division. This dashboard page provides the overview of LMMS according to the respective user type, where each user has different functionalities.
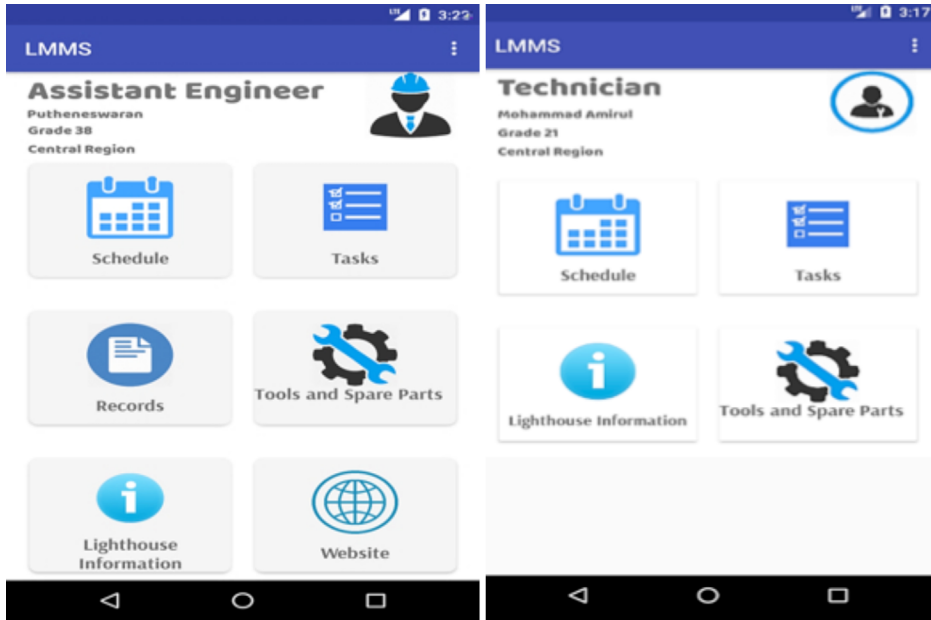
Figure 5: Dashboard for Assistant Engineer and Technician
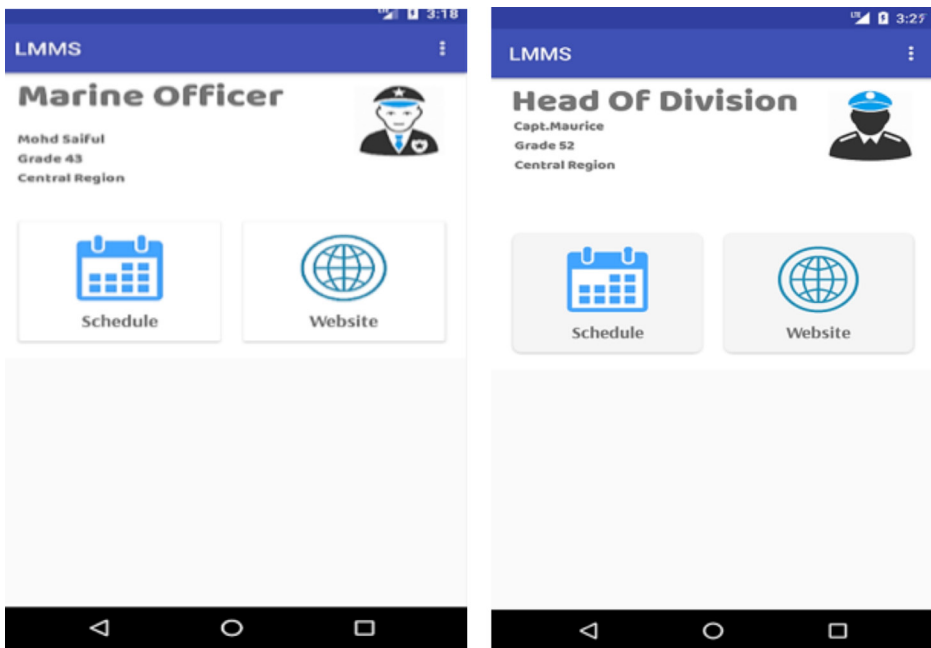
Figure 6: Dashboard for Marine Officer and Head of Division

Manage Maintenance Schedule Module

Figure 7 shows the managing maintenance schedule upload page where the user can upload the schedule and view the schedule status. In the upload schedule, the user can generate the schedule before uploading it. Figure 8 shows the schedule generator and maintenance schedule status, including the maintenance schedule's verification and approval status.
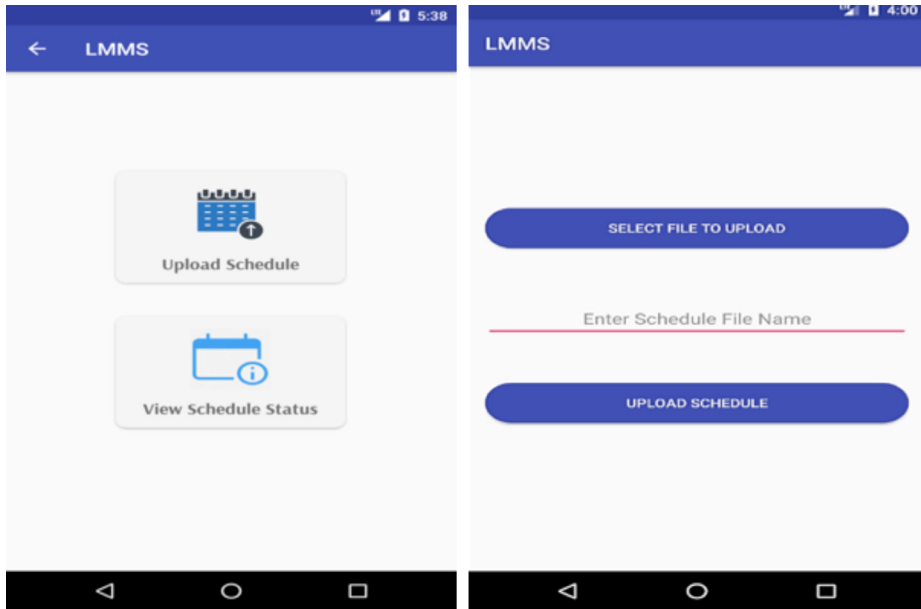
Figure 7: Maintenance Schedule Upload Page
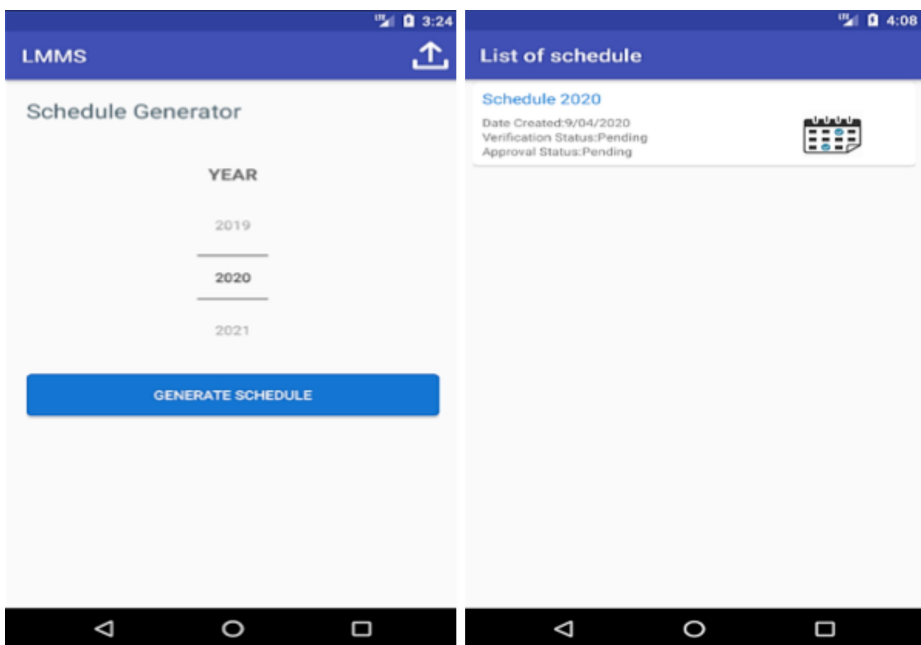
Figure 8: Schedule Generator and Schedule Status

Manage Maintenance Task Module

Figure 9 shows the lists of maintenance tasks and adding maintenance task pages. In Maintenance Task, the user can view the task list and add maintenance tasks containing dates, lighthouse name, available technician, and task details. Figure 10 shows the management of maintenance tasks where the user can view, edit, delete and give feedback for the tasks.
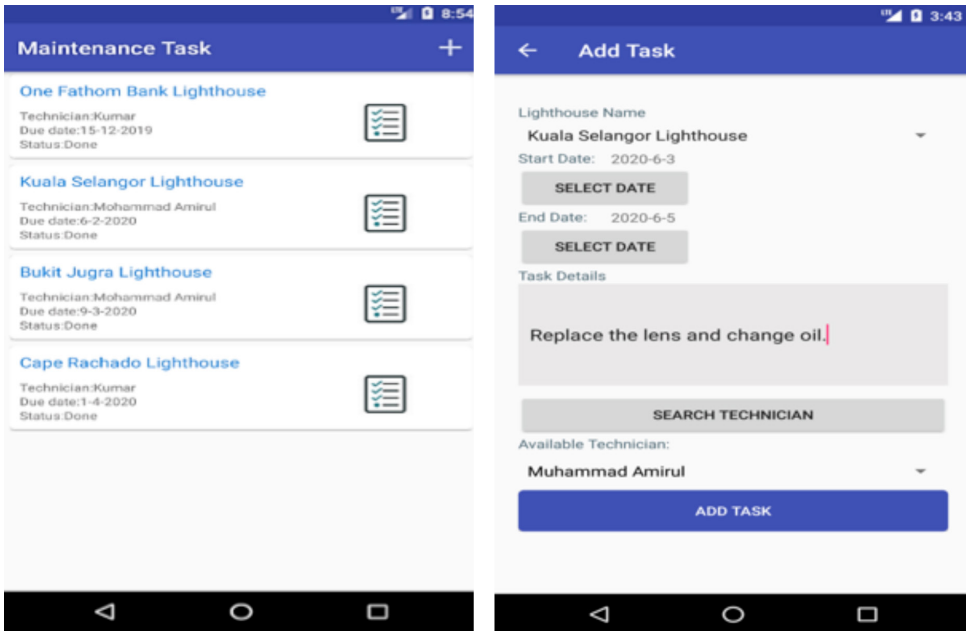
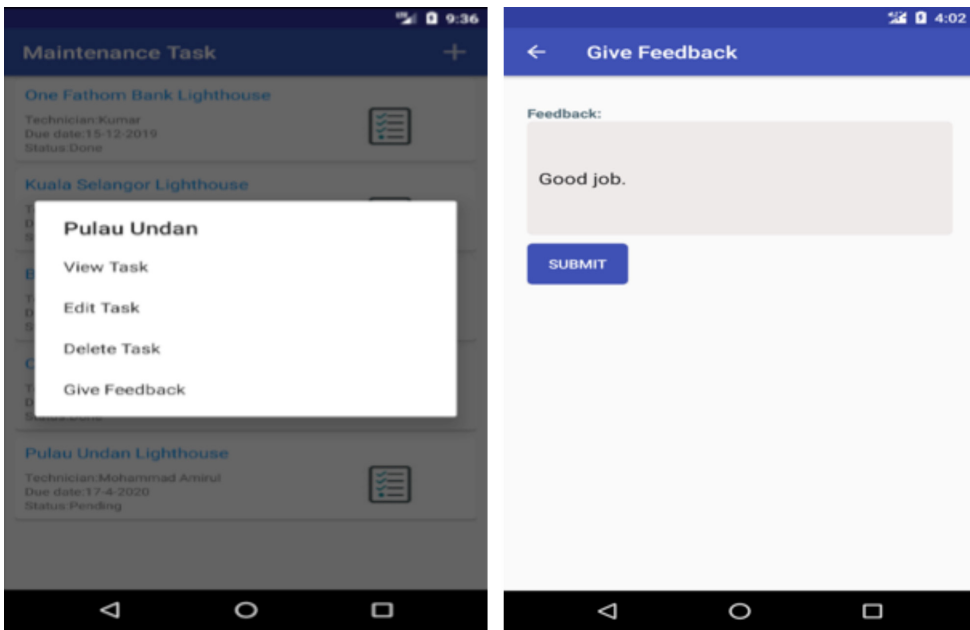Figure 9: Lists of Maintenance Tasks and Adding Maintenance Task Pages

Figure 10: Managing Maintenance Task

View Maintenance Record Module

Figure 11 shows the types of maintenance records and list of records pages, while figure 12 shows the maintenance report and graph record. All the maintenance-related history records can be accessed by the user anytime. Besides, the graph allows users to view the number of maintenance cases for each month and year.
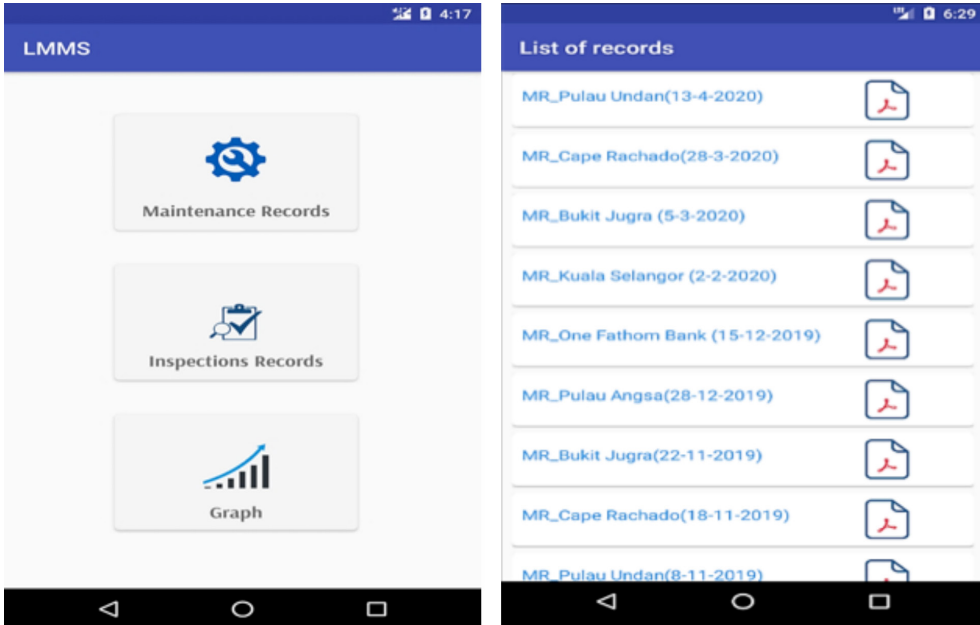

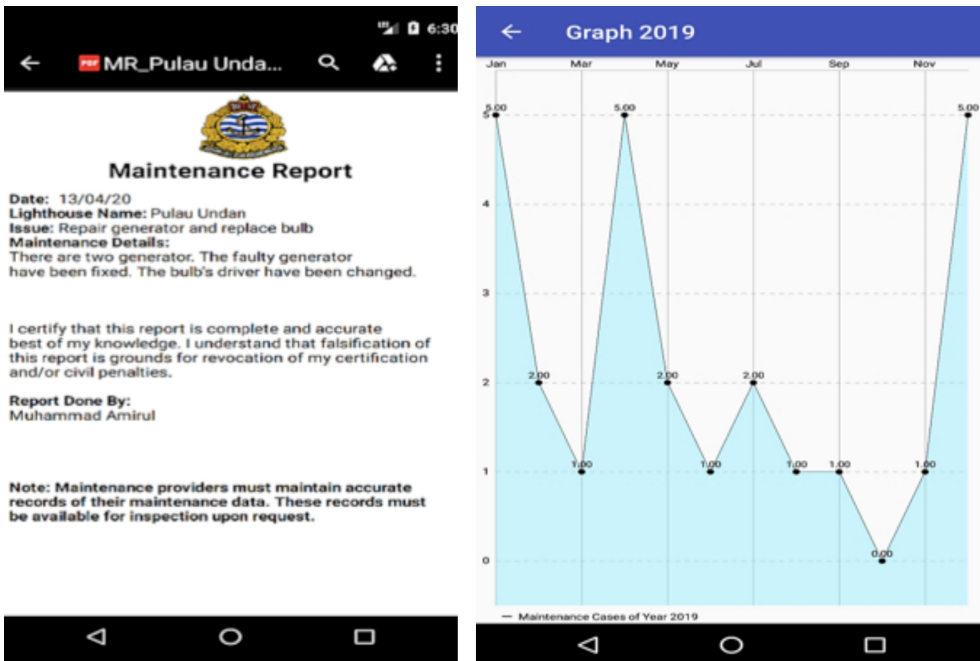Figure 11: Types of Maintenance Records and Lists of Records Pages

Figure 12: Maintenance Record and Graph Record

Manage List of Spare Parts and Tools Module

Figure 13 shows the lists of spare parts and tools data page while figure 14 shows the managing list of spare parts and tools module. The user can add, edit, view, and delete the spare parts and tools list. This module helps users access the list of spare parts and tools needed for lighthouse maintenance tasks.
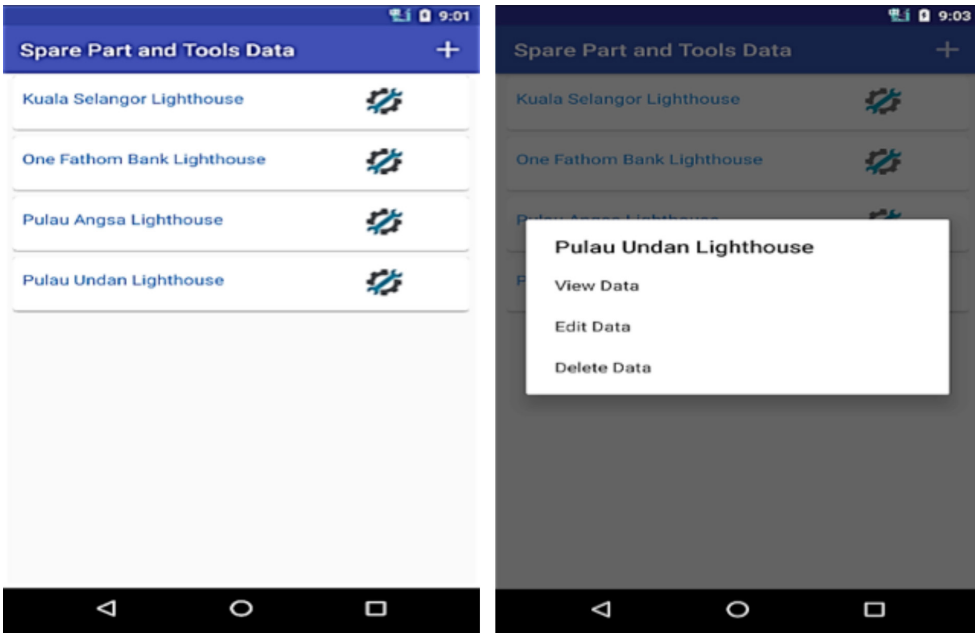

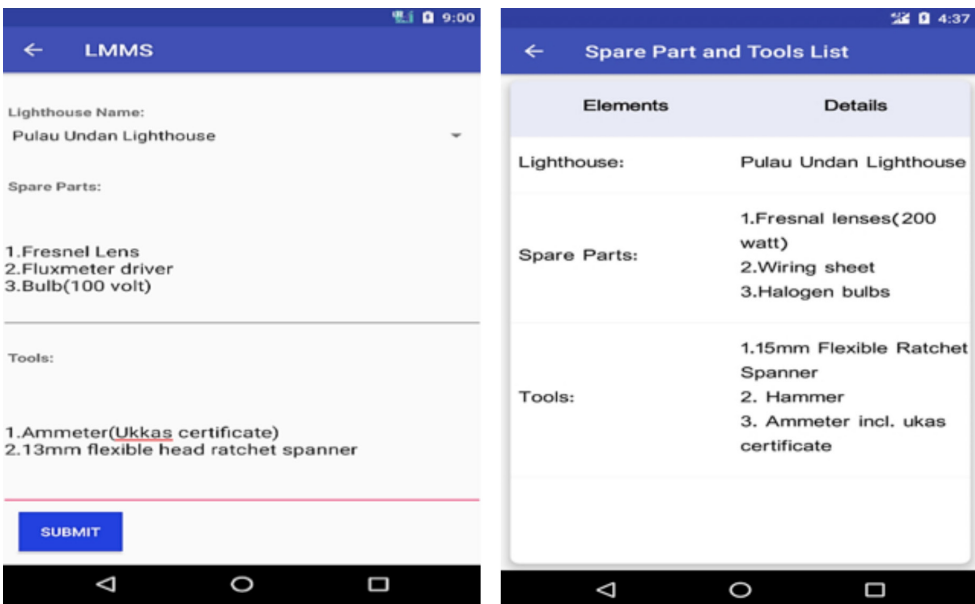Figure 13: Lists of Spare Parts and Tools Data Page

Figure 14: Managing List of Spare Parts and Tools Module

Manage Lighthouse Information Module

Figure 15 shows lists of the lighthouse information page while figure 16 shows the managing lighthouse information module. The user can add, edit, view and delete the lighthouse information. The module focuses on providing information on lighthouses to the users.
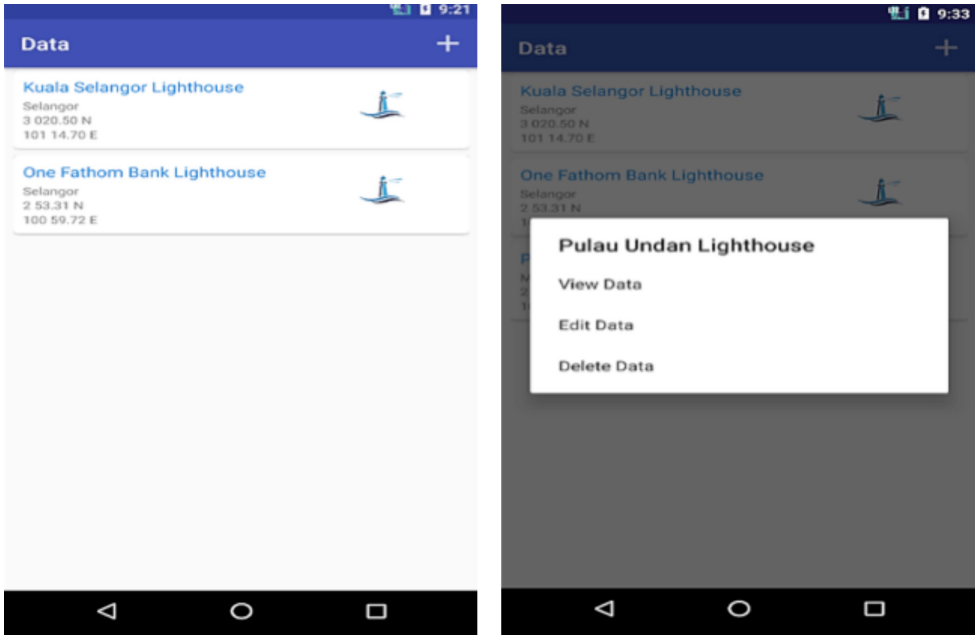

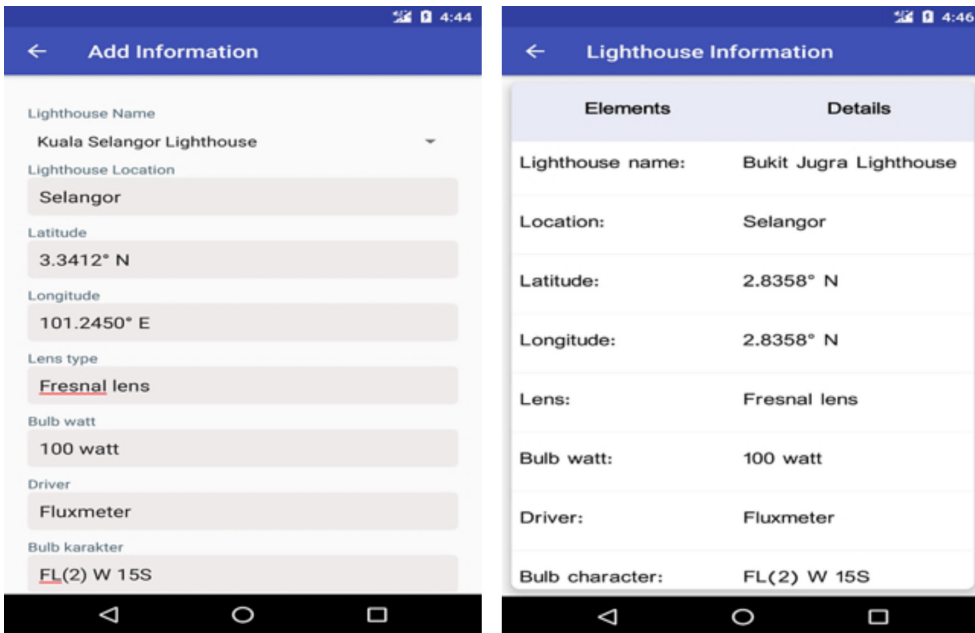Figure 15: Lists of the Lighthouse Information Page

Figure 16: Managing Lighthouse Information Module

View Marine Department Website Module

Figure 17 shows the Website module. The user can view the Malaysia Marine Department website. The users can frequently get the new updates from the Jabatan Laut Malaysia (JLM) website.
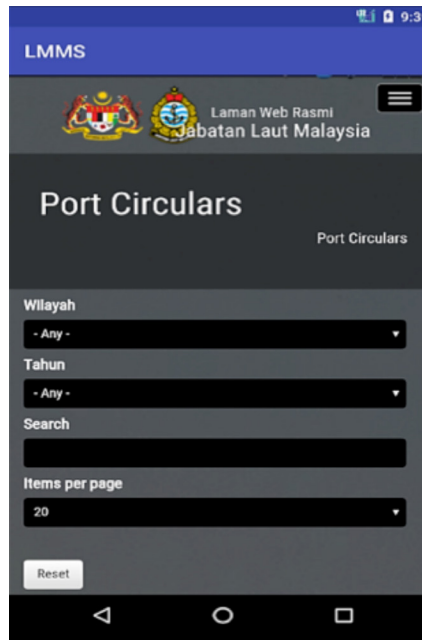

Figure 17: Website Page

System Contribution

LMMS has a few main contributions to Malaysia Marine Department that still use the manual method in managing lighthouse maintenance. Firstly, LMMS provides an online platform to distribute the workload and maintenance schedule so that the maintenance operations are organised and accessible. Maintenance operations can also be observed via LMMS which helps the assistant engineer track the status of the tasks given. In addition, LMMS helps the technician create reports so that their time can be saved and also minimises human error in making reports.

Then, LMMS helps store the maintenance-related records, which provides reduced storage space and easy retrieval. Furthermore, this LMMS is designed for the mobile platform where nowadays, people rely on their mobile apps as it provides convenience and flexibility. This mobile platform also helps the technician to view the list of spare parts and tools and lighthouse information anytime for reference purposes.

Conclusion

In a nutshell, Lighthouse Maintenance Management Mobile System (LMMS) is an android based mobile application intended for lighthouse maintenance management. This application is specifically designed for the Central Region of Marine Department Malaysia. The users of this application are assistant engineers, technicians, marine officers and the head of the division. This application has six modules where users can manage maintenance schedules, manage maintenance tasks, view maintenance records, manage lists of spare parts and tools, manage lighthouse information and view the marine department website. Careful planning, analysis and design of the system were carried out to ensure that the project was completed on

a timeline basis. The hierarchical system menu in this paper explains the overall system modules and functions in the hierarchical diagram and the system development section explain the system interfaces and how the system functions. As a result, deploying LMMS in Marine Department Malaysia of the Central Region helps and eases the lighthouse maintenance management and eliminates paperwork.

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