Meter Reader Complaint Management Mobile App and Metering Web Based System for National Water Supply and Drainage Board

M.K.A.M Jayarathna

2018

Meter Reader Complaint Management Mobile App and Metering Web Based System for National Water Supply and Drainage Board

A dissertation submitted for the Degree of Master of Information Technology

M.K.A.M Jayarathna
University of Colombo School of Computing
2018

Declaration

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

Student Name: M.K.A.M Jayarathna

Registration Number: 2018/MIT/036

Index Number: 18550362

Signature: Date: 29/11/2021

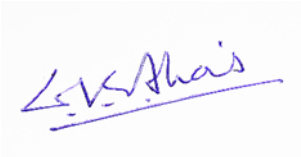
This is to certify that this thesis is based on the work of

Mr./Ms.

under my supervision. The thesis has been prepared according to the format stipulated and is of acceptable standard.

Certified by:

Supervisor Name: Prof. G. Kapila. A. Dias



Signature: Date: 29/11/2021

Abstract

This study is aimed to provide all-inclusive mobile solution to cover the Meter reader complaint management process in National Water supply and Drainage Board (NWSDB) in Sri Lanka, which controls all major functions of supplying of purified drinking water and sanitary service in Sri Lanka.

The current meter reader complain management process is manual and time-consuming process. It includes lots of manual form fillings and data entering. There is no proper method to reconcile the inventory used and measure the workers performances. Hence NWSDB needs a real-time, paperless, error free and mobile solution to address the situation.

'Meter reader complaint management' mobile app and the web based 'Metering' system can address the issues in the current process and improve the performances of the complaint handling process. Meter reader complaint management app integrate with Mobile meter reading app, Metering system, Inventory Management system (IMS) and Human Resource Management (MRM) in NWSDB. This solution provided paperless transparent process to manage meter reader complaint. It also provided method to reconcile inventory usage and labor working hours. The system improved the efficiency and the accuracy of the whole meter reader complaint management process.

Meter reader complaint management app was developed using android studio to create more solid and stable native app. App was developed using the latest version of the android studio, compiled with SDK version 29 and min SDK version 22 to enable the use of app to wide area of operating systems. Web services ware used to communicate with all the systems via mobile app. Metering system was developed using Visual Studio 2015 with the targeted .net framework of 4.5. Both web-based system and mobile app was developed using the RAD methodology.

According to feedbacks of the users and current statistics the proposed system fulfilled both functional and non-functional requirements of the proposed system. Users embrace the solution with shorter period because they are satisfied with the functionalities of the solution. This system will inherit technologically advances smart mobile crews to NWSDB to achieve its vision and mission in future.

Acknowledgment

I take this opportunity to express my gratitude to everyone who helped me and guided me to complete the project successfully.

First of all, I would like to offer a special thanks to my Project Supervisor Prof. G. Kapila. A. Dias for the guidance, supervision, and support provided throughout my project to succeed and to submit the relevant documents on time.

My straight appreciation goes to the staff in NWSDB Maligakanda Regional office for all the help that provided in information gathering, Implementation, Testing and evaluation.

Also, I would like to thank all the members of the academic and non-academic staff at UCSC for the support that was given.

I would also like to express my thanks to my friends for their valuable guidance and support that I will never forget.

Finally, I wish to thank my family for giving me support and helping me in many ways to complete my project successfully and on schedule.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

CRUD	Create, read, update and delete
GIS	Geographical Information System
IIS	Internet Information Services
IMS	Inventory Management System
MIN	Material Issue Note
MIT	Master of Information Technology
NWSDB	National Water Supply and Drainage Board
OIC	Officer in Charge
OS	Operating System
PHP	Personal Home Page
RAD	Rapid Application Development
SMS	Short Message Service
SQL	Structured Quarry Language
VPN	Virtual Privet Network

Chapter 1: Introduction

This report is the result of a thesis study for the Master of Information Technology program (MIT) at Colombo University School of Computing. I have employed at the National Water Supply and Drainage Board (NWSDB) and have identified current work requirements in relation to academic knowledge acquired during the master's program. That is how the "Meter Reader Complaint Management Mobile App and Metering Web Based System for National Water Supply and Drainage Board" was originated.

1.1 Project Overview

1.1.1 About NWSDB

The National Water Supply and Drainage Board (NWSDB) has been established since 1975 as a reputable legal organization in the field of providing purified drinking water and sanitary engineering island wide. The NWSDB is currently operating under the Ministry of Water Supply. It is Sri Lanka's primary authority to facilitate drinking water and sanitation. Currently, NWSDB serves about two and half a million customers.

NWSDB conducts supervise research, planning, design and construction of water and sewer supply projects with local funding and donor assistance, feasibility study, cost estimation and environmental impact assessment of such projects. NWSDB also responsible for Operations and maintenances of water supply and sewerage schemes (NWSDB, 2012).

1.1.2 Current Meter Reader Complain Handling Method

At present all the received meter reader complaints are handled manually. When meter readers capture complaints from the Meter Reader Mobile app it will directly uploaded into a (1) Metering System. When the billing cycle is ended each administrator transfers the data (which include readings along with the complaints) into (2) core Billing System.

Then the commercial officers take (3) relevant reports and sort list the complaints to be handled. then they create work orders and assign them to each (4) OIC office. Each OIC gets work order list from the billing system and prints all of them for each (5) maintain crew. Then the maintain crew pick the (6) work orders from the office and attend them.

When the job is done those officers need to fill the (7) manual forms and hand them over to the office. Then the office data entry operators (8) update the relevant work order as done with relevant details.

The described process is shown in this diagram (Figure 1.1)

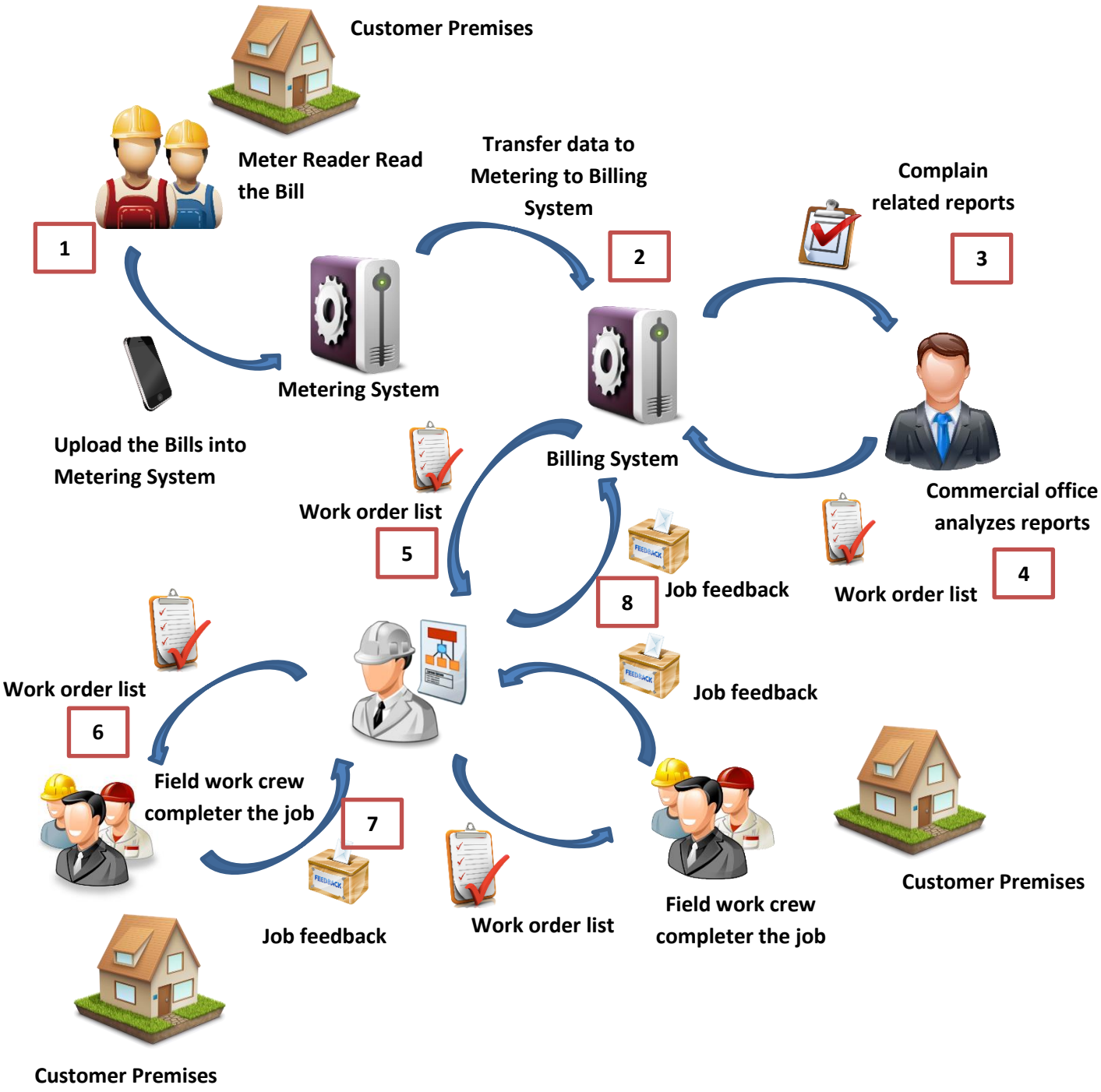


Figure 1.1 - Current Meter Reader Complain Handling Method

1.2 Motivation

The following are the shortcomings in the existing complaint handling method,

- National Water Supply and Drainage Board has over 2.3 million customers all around the country. All these customer accounts are grouped by Regions, Areas and Dockets. There can have a maximum of 999 records per one docket. In each area these dockets are mapped to Zones.
- Each Zone has a dedicated Crew lead by an Engineer or Engineer Assistant which handles all the meter reader complaints that come to them.
- Water board receives Meter Reader Complaints through Mobile Meter Reading App which use to capture meter readings islanded.
- In presence all these complaints are handled manually. There are lots of manual assigning, paper fillings and documentations include in these processes.
- The current process slows the field works and waste hours of valuable time in both office and field workers.
- In another domain, currently there is no method to track the actual progress of the complaint handling crew, there working hours or reconcile the usage of inventory for each job they complete.

1.3 Objectives

Ultimate goal of the Meter Reader Complaint Mobile app is to drop all the manual assigning, form fillings and documentations related in this process and provide all in one solution to the meter reader complaint handling crew and make them fully mobile crew that do not essential to come to office daily to gather bundle of documents. Followings are the key objectives in my project.

- 100% paperless process for meter reader complain handling
- Improve the efficiency of complaint handling by reducing the response time to 12 hours
- Improve the accuracy of data that collect in compliant handling
- Enhance the user satisfaction with user-friendly all in one solution
- Improve the customer satisfaction by providing efficient and smart service through quick reply, SMS alerts, Spot printing and digital signature
- Decrease the Inventory misuse and waste in complaint handling field works by capturing inventory for each separate job and finally reconcile the usage

- Improve the transparency of meter reader complain management process by tracking crew location, Inventory and Human resources
- Capture 100% accurate working hours of each user that uses for performance management and over time calculations

1.4 Background of the study

To overcome the shortcomings that listed above and improve the efficiency of meter reader complaint management process, the manual service process has been studied in detail and an automated and online system has been developed with following functionalities.

- Here in the proposed system, the manual enrolment of the employees to meter reader complain management process and fully automated the total process.
- Meter reader complaint are properly mapped to relevant offices and auto shortlisted according to the given instructions.
- Just after Meter Reader capture the complaint, the record will automatically be forwarded to the relevant crew leader.
- Then the crew leader selects the jobs and use the details to analyze the situation (reading history, Payment history, Complaint history, contact details, PS details etc.…)
- While finishing up the work he can capture related details of the job, Inventory details that used and human resources that used.
- System allow to take the digital signature of the user and provide 3-inch thermal printout to the customer and update the main system of the completed job.
- Metering system will use to do all the management and analysis related to the Meter reader complain management app.

Described process is shown in this diagram (Figure 1.2)

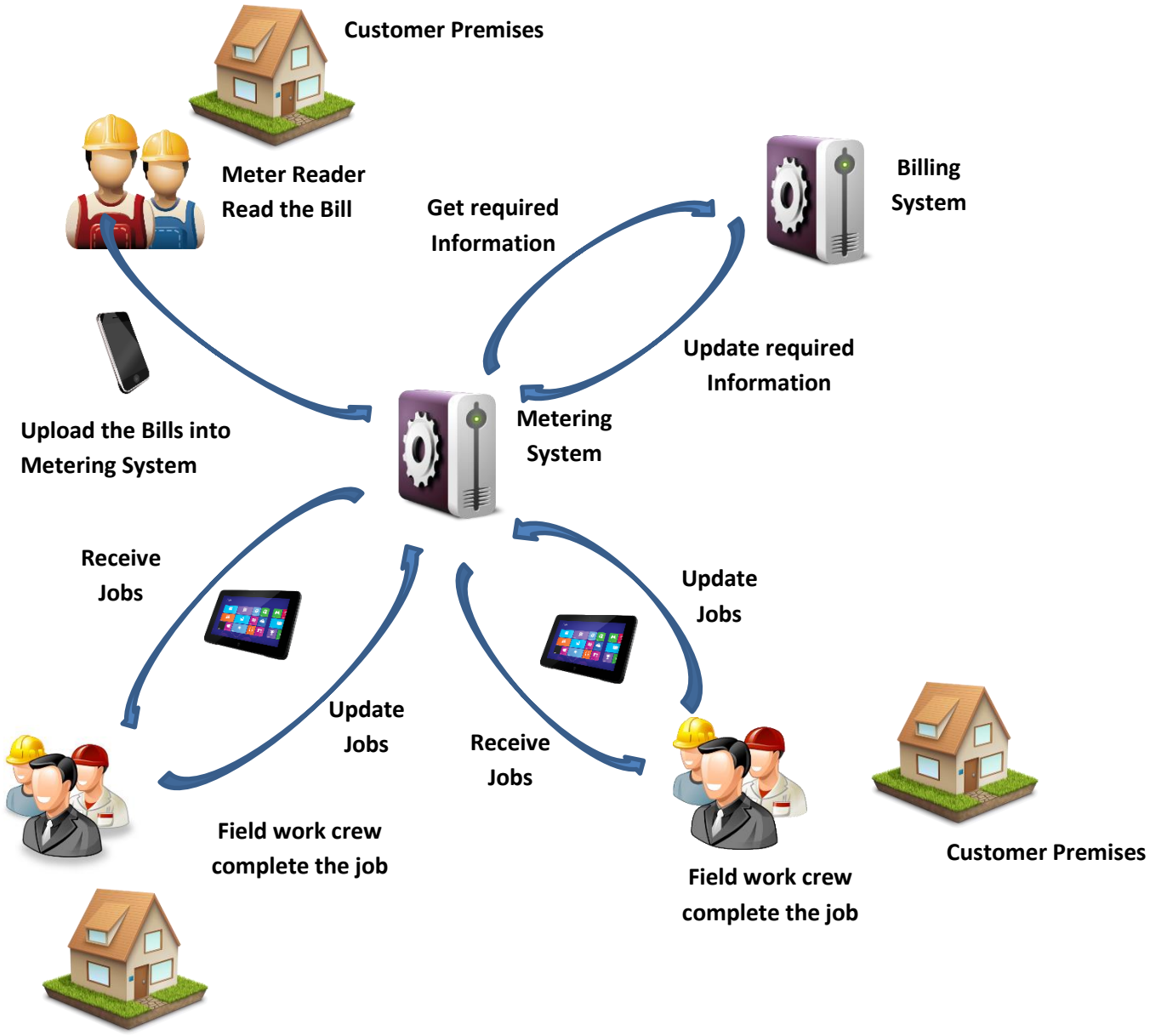


Figure 1.2 - Proposed Meter Reader Complain Handling Method

1.5 Scope of the study

Project scope of my study covers the total process from meter reader complaint capturing to completing the job relate to the complaint. All-inclusive solution with inventory management and labor management. This solution also addresses the non-functional requirements of the process. Following is the complete scope of my study

- real-time interface

  Mobile crew can see all the Jobs they have as soon as complaint captured from Mobile Meter Reading App which use for collecting Meter Reading in Water Board.

- List View and Map view

  Crew leader can select next job using two separate views, List view and Map view. List View show details of the job with selected sorting criteria's and Map view helps to select nearest job to current location of crew.

- Accurate Navigation

  Crew can use google navigation support to find the job site using GPS coordinates which collected by Meter Readers using Mobile Meter Reading App (We have more than 50% of our customers GPS locations which collected through Mobile Meter Reading App and GPL collecting devices).

- Background Check

  Meter reader Complaint Management app will be able to provide all the details related to specific account number such as Customer Information, Connection Information, Bill History, Payment History, Complaint History (We use Customer Details, Payment Details and Account Details from water board billing system and Reading Details, Complaint Details and Consumption Details from water board Metering System)

- Define Team

  Crew leader can select the crew members that participating to the job and how many working hours that they spent on specific task. Then we are able to calculate actual human resource cost that we used for each job.

- Define Inventory

  For each crew I will manage separate inventory levels which they can add items using MIN (Material Issue Notes) number through IMS (Inventory Management System in NWSDB). For each job crew leader can select what are the inventory items that used. System can generate total inventory cost for the job. (I will use data from water board Inventory Management System)

- Digital Signature

  Crew leader need to get signature from customer after job done. Through App we are able to capture Digital Signature. System can provide printed receipt on site to customer along with both customer and Crew leader signature.

- Issue printed document after job done

  Finally, App can give printed receipt on field using mobile printers (we can use 3-inch mobile printers). It will contain all details about the job, digital signature of customer, Crew leader details, Human and Inventory cost for the job.

- User, Crew management / Docket Crew mapping

  Creating users, crews and mapping dockets to crews can be done using web interfaces in Metering System (Existing system to manage meter reading mobile app)

- Dashboard

  All in one Dashboard to review the progress and related information's of complaint management jobs.

- GIS Maps

  In Few areas water board have fully developed GIS map layer which include all the pipe lines and their details. I will enable a link in my app to connect with GIS servers and view the map if available. It will help to identify the layer of pipe lines for diggings and affected areas for water cuts.

- SMS alerts

SMS alert will send to the customer mobile number (if available in customer details) when crew heading for the job and after job done. (I use customer mobile numbers in both Billing system and Metering system)

1.6 Feasibility Study

A detailed feasibility study for this solution was carried out under following feasibility categories

1.6.1 Economic Feasibility

Economic analysis is the most frequently used method for evaluating the effectiveness of a new system. In here analyzed the existing manual system with proposed system. In this analysis considered the manual system time wastage of each processes, number of employees used and their salary and costs, paper wastage as weak points. However, compared to proposed system, it was noted that majority of drawbacks stated in the manual process could be reduced with proposed system. Hence, proposed system would be economically viable project.

Here, the existing manual system is analyzed with the proposed system. According to the analysis existing system has economical drawbacks as followings,

- Wastage of time in the manual process
- No of employees occupied in the same process
- Employees redo the work unnecessarily
- Ability to misuse the organization resources
- So many untrickable processes and unable to monitor blind spots

All those drawbacks cost organizational money for employee wages, papers, misused resources. With increasing of the time to attend the compliant such as Defective Meter. Illegal water connection, User category change, cannot satisfy about the Consumption may affect the organization economically.

The proposed system is economically feasible because

- This system will create a fast and efficient automated environment instead of a slow and erratic manual system, reducing the time and labor required to operate the system.
- Attending complaint asap will save lots of money wastage for the organization.
- System helps to manage Organization inventory to its optimal usage without any resources misusing.
- Remove documentation and printing cost.
- The system will have user friendly user interfaces that require less user-training to learn it.

However, it is noted that most of the shortcomings identified in the manual process compared to the proposed system can be mitigated by the proposed system. Therefore, the proposed system will be an economically feasible project.

1.6.2 Technical Feasibility

This mobile app will used by the engineers or engineering assistants. These employees have good education background and awareness of using smart phones and mobile applications. More than 90% of them are in 25 to 40 age range. Metering system is already implemented system and people who are responsible to handle the complaint management mobile app related information's are already in this system as users. The proposed system is technologically feasible.

1.6.3 Operational Feasibility

Following factors make the proposed system operationally feasible

- NWSDB provides tablet computer with 8.0-inch display
- Every crew get a one tablet computer
- Tablets are owned and maintained by NWSDB
- Tablet computers are not specified for each crew, they can login to any device and use it for their work
- Tablet computer wide display will help to enter data easily in the field
- NWSDB provides 3-inch thermal printers that can easily hand in the belt
- Every phone equipped with pen, hard back cover and waterproof cover
- Colors in the app are specially choose to suit in the outdoor environment

1.6.4 Legal Feasibility

NWSDB has a strict legal policy that no to allow external parties to access their internal data, Because of that all the data transaction needed to be handled using internal resources.

All Services that developed are hosted inside the NWSDB data center to communicate with the mobile application.

Metering system can access through the VPN connection or Internet under the waterboard domain.

Chapter 2: Background

2.1 Introduction

This chapter consists of requirement analysis, literature and research revelations based on complaint management domain. Here I explain the relevant technology that I was used.

2.2 Requirements Analysis

Requirements management is a primary part of the project. Once the project requirements have been met, they must be analyzed and check for ambiguities to be solved. Next, determine the flow of the project. This is followed by a process of maintenance, analysis, assignment, prioritization and agreement on changes to the system documentation requirements. Unconditional acceptance of the new requirements will influence the quality of the project and lead to project delays.

When online service management system is developed, systems analysis would represent the following steps:

- Leading requirements gathering processes to identify the needs of end users of the system
- Develop a feasibility study to determine if the project is economical, technologically, operationally and legally feasible
- Determine how end users operate the system and weather the system will able to satisfy the all user requirements

2.2.1 Requirements Gathering Techniques

I have selected Maligawatta regional office to gather information because this office handles all types of complaints. They also work with minimum recourse to handle huge amount of complaints with limited time frame. So, they are really like to go for more efficient way of handling meter reader complaints. Here are some requirements gathering methods that I used.

2.2.1.1 Interviews

Interviews allow for quick answers and immediate clarification of doubts. In addition, indirect observations may be made during the interview. This led to the collection of the most important information, the definition of its requirements, roles and responsibilities, an understanding of the process and what is expected from the proposed system.

I Interviewed Commercial officers, OICs, Engineers, Engineering Assistants to gather information to get a clear view of the current process.

2.2.1.2 Observation

Observing users in the work environment is another accurate method that I used identify system requirements. In addition to the information that I gathered from interviews there were lots of information's that I collect by observations.

I start my observations from the Maligawatta office commercial officers complex. I observed how they generate reports and manually shortlist the complains to be handled. Then I went to two OIC offices and observe the work process that the do to handle the complaints.

2.2.1.3 Field Visits

Without sticking inside the office, I went out with a mobile crew to see the actual environment that they had to work and to analyses the operational feasibility in the real world. From their I collected the information that they required to complete their job perfectly.
This field visit helps me to identify the behaviors of the customers and what they really expect from the waterboard crew.

2.2.1.4 Prototyping

The prototyping was used to identify uncertainties in the proposed system requirements and to ensure that the requirements were correctly defined.

I used paper prototypes to make the requirements clearer. I show them to the commercial officers and field engineers to make sure the requirements that understand are correct. This method helps me to final confirmations of my requirement analysis process

Following are the requirements that I gathered through this proves

2.2.2 Functional Requirements

Following are the list of functional requirements which have identified during the requirement analysis:

2.2.2.1 Meter reader complaint management app

In Meter reader complaint management app, I identified following functional requirements

- Should forward meter reader complaints to the relevant field officer just after record uploaded
- Field officer should be able to show available complaint to his crew.

- Field officer should be able to add items to his virtual inventory through the MINs.
- Field officer should be able to sort complaint using date, type and priority.
- App should provide list view and the map view of the complaints.
- Field officer should be able to view personal details, account details, payment history, meter reading history and compliant history of the selected account number.
- Field officer should be able to use location service through the google maps to rout to the location of the customer.
- Filled officer should able to capture relevant details regarding the job such as Solution that provided, Meter details, Connection details.
- Filed officer should be able to capture the inventory details with amount that used to complete the job.
- Field officer should be able to select the team members that participate to the relevant job.
- Field office should be able to capture photos if necessary to attached to the job.
- Field office should be able to enter the time spent to complete the job.
- App should be able to capture coatomer digital signature.
- App should be able to calculate Inventory cost and the labor cost for the final output.
- App should be able to provide printed output related do the job completion.
- App should be able to update the job status just after the job completed.

2.2.2.2 Metering web-based system

In Metering web-based system, I identified following functional requirements

- System should provide facilities to manage Docket vs Field officers mapping
- System should provide facilities to manage Crews vs Crew Members mapping
- System should support CRUD functions for Crews in each region
- System should support CRUD functions for Crew Members in each Crew
- System should provide facilities to monitor progress of the complaint management process
- System should provide facilities to monitor progress of the inventory and labor usage of each crew.
- System should provide facility to view all relevant details of completed jobs.
- System should provide secure access for each user only to relevant region and under relevant access rights
- System should be able to sed SMS in relevant stages to relevant users.

2.2.3 Non-Functional Requirements

Following are the non-functional requirements in the system:

Performance - The system should respond quickly to user requests. Once the request is made, the data will be ready and the request for information from the system will be available with a single click. The screen should load quickly.

User friendliness – both app and the web-based application must ne user friendly. People that use the systems can me in different computer literature levels and the users can be change rapidly. So, giving complete user training for new users will be endless process. So, the system must be user friendly that users can self-learn to use the service.

Reliability Here we work with customers with the strict schedule. So, the mobile app should be 100% reliable. This Complaint management app is an online app. So, the connection with the servers should be manage carefully.so here I used Web Services to communicate with minimum connectivity with rollback facilities.

Availability - The Metering system will be available to the user on the internet and VPN for all time. Complaint management app will be available only thorough he internet for all the time. If delays occur and are anticipated in advance, advance notification will be required to minimize lost data and inconvenience.

Security – User account for the Metering system will be created and managed by system administrators in island wide. They are also responsible for the CRUD functions of crews and crew members.

After they create crew leaders, those users can log into the app and do their job. App users can change their password as they required. Inventory can be added only through the approved MIN in relevant region. Inventory cannot amend manually by app users.

System backups are scheduled and keep safely.

Maintainability - System will be maintained by the IT division. And also, system and software documentation will be provided and that will give instruction about use and maintenance of the system.

The system will be managed by the NWSDB IT division. There will be complete system and software documentation, which will give instructions on how to use and maintain the system.

2.3 Review of Similar Systems

Following is the review of two similar systems that I have identified,

- Mobile Field Service Solution by IFS (IFS, 1995).

This mobile app provides a full range of tools for field engineers, allowing employees to do just about anything they need from their mobile device, such as finding spare parts, increasing new workloads, or sending customer quotes.

It can connect to enterprise resource planning system and customer relationship management solutions if required. Following diagram (Figure 2.1) show some of the features of the Mobile field service solution.

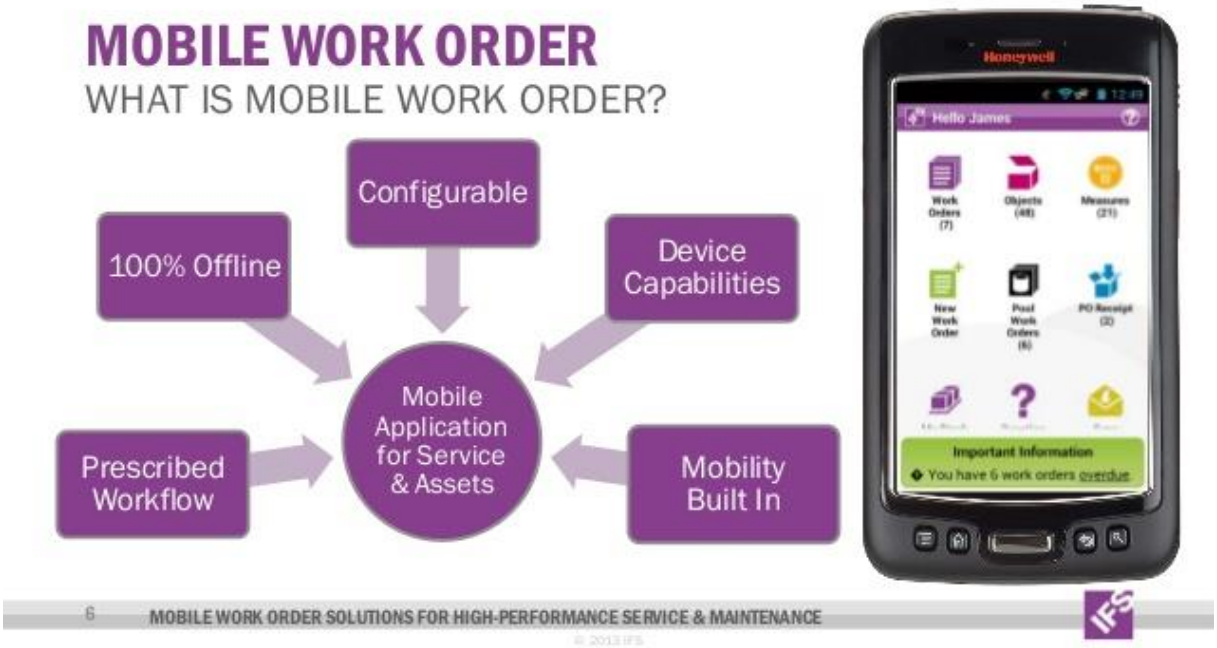


Figure 2.1 - Mobile Field Service Solution by IFS (IFS, 1995)

- FLOBOT - JOB MANAGEMENT FIELD SERVICE SOFTWARE (Milk, 2019).

FLOBOT is destined to trade in Sri Lanka. FLOBOT can use to plan, submit, create invoices, make estimates, make estimates, make reports, make payments, manage contractors for customers and work orders for engineers and technicians. Following diagram (Figure 2.2) show some interfaces of the FLOBOT app.

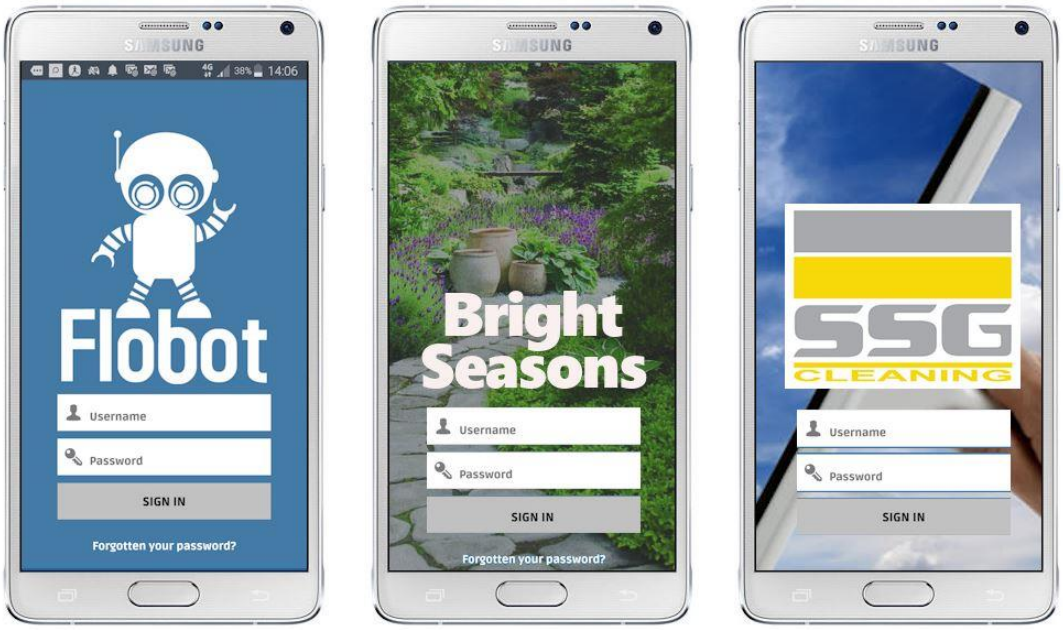


Figure 2.2 - FLOBOT app screens (Milk, 2019)

- TaskCare - Field Service Management (FSM) App (LaneSquare, 2020)

TaskCare helps companies conduct effective field service activities. Plan your day's work, assign and manage specific tasks or packages, manage attendance, collect payments, data, research, review documents, create reports, analyze, and improve performance. It offers you the best performance even when the device is offline and online. Followings are the main features of TaskCare

1. Route Optimization
2. Task Management
3. Attendance Management
4. Custom Form Creation
5. Expense Management
6. Payment Collection
7. Document Verification
8. Survey Management
9. Reports & Analytics
10. API Integration

Similarities and Differences

Here in this table (Table 2.1) contain the summarized comparison between IFS solution, FLOBOT and Proposed system.

Mobile Field Service Solution by IFS	FLOBOT	Proposed Solution
complete feature-rich toolkit for field engineers	facilities maintenance companies	Manage Meter reader Complaints
native mobile apps for Android, iOS and Windows devices	available through a browser on any device	Native mobile app for Android
secure mobility platform		Communicate with internal systems of waterboard using web services
use GPS to find nearby parts and get directions	Navigate from job to job by utilizing the built-in maps function	Use GPS to navigate to the customer location
	The dashboard gives real-time visibility of the job	Use dashboard to view progress in app and Metering system
	You can bill by the hour if you want with the built-in timer	Can enter the time spent for the job and calculate man-hour rates
order parts		Capture inventory items that use for the specific job and calculate the value
enter labor and expenses		Enter labor and inventory
take pictures	create a job sheet and attach some pictures	Can add photos of completed job
manage notes and payments	receive payments from debit and credit cards, make customer notes	Can add notes
	schedule field members for appointments	Can view customer information and use phone

		numbers to inform the customer via call or SMS
fill out checklists and capture signatures	Attach your 3rd party apps, pdfs, certificates to the job sheet and then get the all-important signatures	Can capture digital signature of the customer and the field officer
Online or offline	online cloud system	Online
Smartphone, tablet or laptop	available through a browser on any device	Can use in any android device

Table 2. 1 - Mobile Field Service Solution by IFS vs FLOBOT vs Proposed App

2.4 Related Design Strategies

Here I described the design strategy that I have used and reason to use that strategy.

- **Rapid Application Development Methodology**

  Rapid Application Development (RAD) is a development model that gives priority to rapid source modeling and rapid response over long processing cycles and tests. Because applications evolve so fast, developers don't have to do many iterations and updates to the software quickly and start the development schedule from scratch. Following figure (Figure 2.3) is a graphical representation of the RAD model.

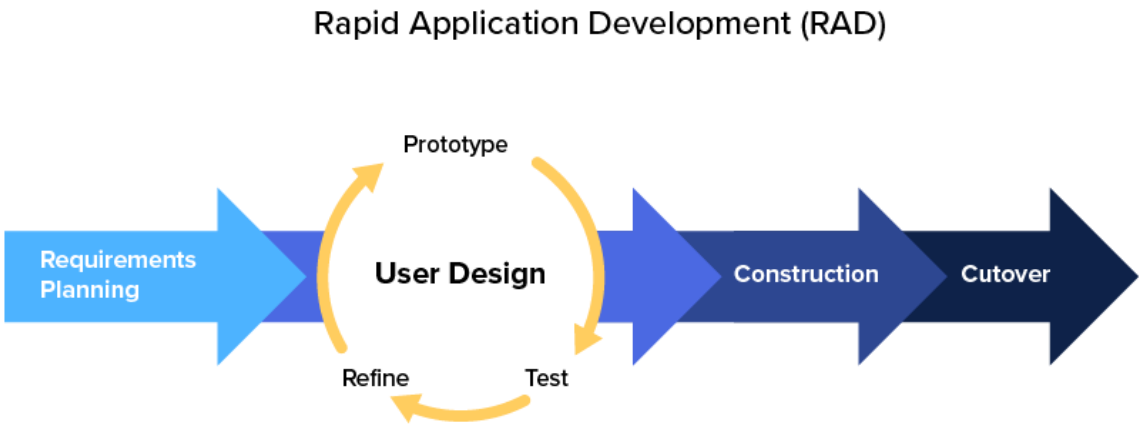


Figure 2.3 - Rapid Application Development Model [5]

Steps in Rapid Application Development

1. Define the requirements
2. Prototype
3. Receive Feedback
4. Finalize Software

Define the requirements

Initially, rapid software development differed from traditional software models. It does not require you to stay with end users and get a detailed list of specifications; instead, there is a wide range of requirements. The broad nature of the requirements helps to establish specific requirements at various points in the development cycle.

Prototype

This is where a real development takes place. Instead of following strict requirements, developers make the original design as soon as possible with various features and functions. These prototypes are then shown to customers who decide what they like and what they don't like

Receive Feedback

At this stage, they share their thoughts on what is good, what is not, what is happening, and what is not. Feedback is not limited to pure functionality, but also to visuals and interfaces. Based on this reaction, the initial conception is still developed. Repeat these two steps until the final product meets the requirements of both the developer and the customer.

Finalize Software

Here, the software features, functions, aesthetics and interface are finalized with the customer. Stability, operation and maintenance are paramount before delivery to the customer.

- **Reason to use Rapid Application Development Methodology**

RAD Methodology was the most appropriate methodology that I found with the system requirements and the development environment. Followings are the reasons to select RAD methodology other than Waterfall model and the Agile development methodologies.

1. The RAD method opens the way for continuous feedback through repetitive iterations and prototype versions, providing invaluable feedback and criticism to the developer at the right time.
2. As iterations, components, and prototypes emerge, it is possible to measure project progress and individual components in general.
3. During the development of RAD, the software is flexible. In other words, we can drastically change the software system as a whole or modify the code to create new components.
4. RAD helps such developer quickly build prototypes and work on code to set an example.
5. RAD allows Reuse of code segments because of modularity and prototyping.

- **Rapid Application Development vs Waterfall Models**

	RAD Methodology	Waterfall Methodology	Agile Methodology
Size	Very small and very large	Small and medium	Medium and Large
Risk	high risk	low risk	low risk
Team Size	large	small	large
Best time for changes	At the very beginning	Anytime	Anytime
Product Delivery	delivers product in the end	earlier deliveries	At end of iteration
Waiting Time	available at the end	available as soon as first iteration	available as soon as first iteration
Prototype	No	Yes	No

Table 2.2 – RAD vs Waterfall vs Agile Development Methodologies

Chapter 3: Design Architecture

3.1 Introduction

The design phase of the system is the most important part of the project development. It is very simple and helps developers to have an accurate picture of the system. It can also be used to give clients a clear idea of the project during the project phase.

3.2 System Architecture

The system design architecture is the process of optimizing common quality features such as performance, security, and management, as well as identifying structured solutions that meet all technical and operational requirements. It includes a series of decisions based on a wide range of factors, each of which has a significant impact on program quality, performance, maintenance, and overall success.

3.2.1 Proposed System Architecture

The Meter Reader Complaint Management is a mobile application and the Metering web-based system hosted in centralized server located at the Head Office of NWSDB. Mobile apps in island wide connect with the server through web services. Metering system can be accessed through the both internet and intranet using web browsers.

Access URLs

- Through intranet
  10.0.0.107/Metering
- Through internet
  bis.waterboard.lk/Metering
- Web Services
  http://bis.waterboard.lk/GISLocationService/MRCMService.asmx

Here (Figure 3.1) is the architecture diagram for the proposed system (Clouder, 2020).

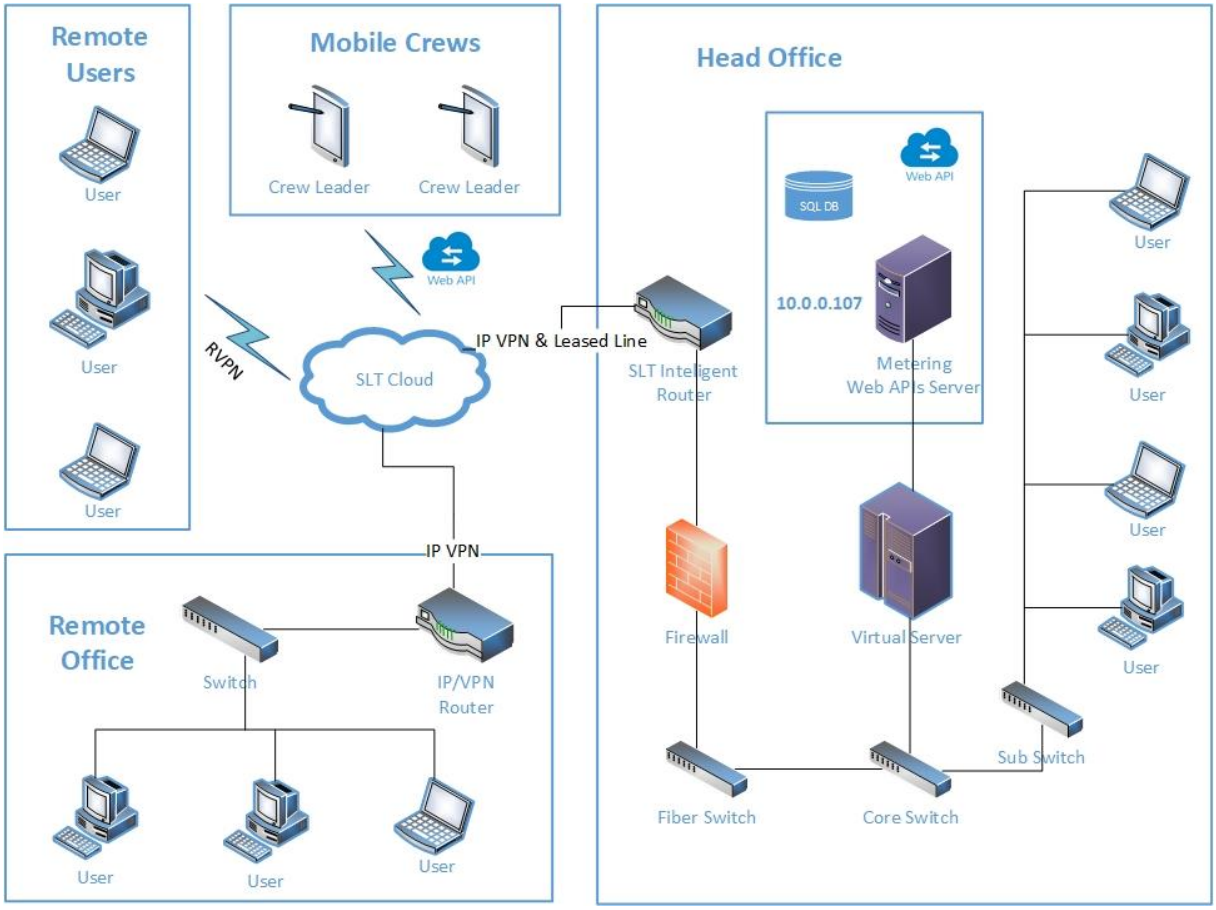


Figure 3.1 - Architecture diagram for the proposed system

3.2.2 System users

Based on the requirements identified during the analysis phase, the system should have a supportive approach based on user validation and the functions it performs. After the requirements and organizational measures were made, it was decided to have four levels of user as follows. User levels are represented in here (Figure 3.2)

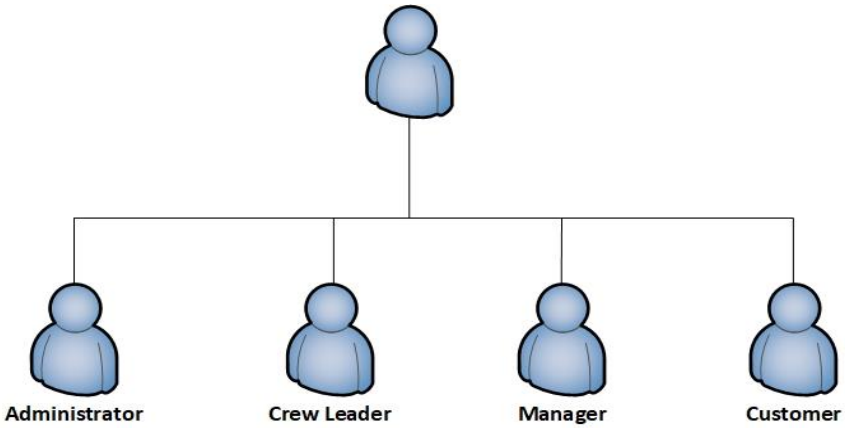


Figure 3.2 - User levels

Administrator – user that can do all the administration function related to the Metering web-based system and Meter Reader Complaint Management mobile app. This user can be mapped to the System Administrator position in NWSDB.

Crew leader – user that use the Meter Reader Complaint Management mobile app in the complaint management process. This user can be mapped to the Engineer or Engineer Assistant positions in NWSDB.

Manager – user that can view dashboard and the reports regarding the Meter reader complaint management. This user can be mapped to the Manager, OIC and CO positions in NWSDB.

Customer – user who own the connection that compliant related.

3.3 UML diagrams

The Unified Modeling Language (UML) was chosen as the modeling language for the proposed solution. UML is recognized throughout the industry as the best software development modeling language.

UML diagrams Enhanced the amalgamation between structural models and behavior models. They have the ability to define hierarchies and break down software systems into components and subcomponents (wilda, 2014).

Following diagrams are generated to define the design of Meter Reader Complain Management App and Metering web-based system.

Behavior diagram

- Use Case Diagram
- Sequence Diagram

Structural diagram

- Class Diagram

3.3.1 Use Case Diagram

In UML Use case diagram identified as a behavior or dynamic diagram. This diagram uses Actors and the Use case to model the functionalities of the system. Actors are users that participated in the processes of the system and Use cases are set of actions, services and function that system performed. Here the Use Case diagram is shown in this figure (Figure 3.3)

Figure 3.3 - Use Case Diagram

3.3.2 Use Case Narratives

Use case narratives are used to describe all the main use cases of this system. Those narratives are help to identify users who are involving the use case and what they have to do in each process. Sample of them is given here (Table 3.1 to Table 3.9) (hmookna, 2018).

3.3.2.1 Manage Crew Details

Author: Akila		**Date: 06/03/2021** **Version: 1.0**
use case name:	Manage Crew Details	Use Case Type: □ Business □ System
use case ID:	1	
Priority:	High	
Source:	Metering system master data	
Primary Business Actor:	Administrator	
Other Participating Actors:		
Other interested Stakeholders:	Manager, Crew Leader	
Description:	Meter reader complaints are handled under a crew. These crew has many members. Crews are generated under each region. Crews must be defined as master data before start the complaint handling. This process includes Create, Update and Delete crews.	
Pre-Conditions	User need to login to the system	
Flow of events	Create 1. Select region 2. Enter relevant details 3. Save Update 1. Select region, crew 2. Do the changes and update Delete 1. Select region 2. Select crew 3. Delete	
Post-Conditions	Successfully created, updated or deleted	

Table 3.1 - Use Case Narratives - Manage Crew Details

3.3.2.2 Manage Crew Members

Author: Akila		**Date: 06/03/2021** **Version: 1.0**
use case name:	Manage Crew Members	Use Case Type: □ Business □ System
use case ID:	2	
Priority:	High	
Source:	Metering system master data	
Primary Business Actor:	Administrator	
Other Participating Actors:		
Other interested Stakeholders:	Manager, Crew Leader	
Description:	Crew members are assigned to each crew. Crew member can be either crew leader or just member. Crew leader can only have permissions to log into the meter reader complaint management app. This process includes Create, Update and Delete crew members.	
Pre-Conditions	User need to login to the system	
Flow of events	Create 1. Select region, area 2. Select member level 3. Enter relevant details 4. Save Update 1. Select region, area 2. Select crew member 3. Do the changes 4. Update Delete 1. Select region, area 2. Select crew member 3. Delete	
Post-Conditions	Successfully created, updated or deleted	

Table 3.2 - Use Case Narratives - Manage Crew Members

3.3.2.3 Manage Crew Docket Mapping

Author: Akila		**Date: 06/03/2021** **Version: 1.0**
use case name:	Manage Crew Docket Mapping	Use Case Type: □ Business □ System
use case ID:	3	
Priority:	High	
Source:	Metering system master data	
Primary Business Actor:	Administrator	
Other Participating Actors:		
Other interested Stakeholders:	Manager, Crew Leader	
Description:	Every water account number includes Region code, Area code and Docket number. Docket number is unique for each Area. Each docket can have maximum number of 999 account under it. Those dockets are required to be mapped to related crew. Then all the complaint comes under those account numbers can be forwarded to the relevant crew. This process includes Add or Remove dockets from the crew.	
Pre-Conditions	User need to login to the system	
Flow of events	1. Select region, area, docket 2. View mapping 3. Add or remove dockets 4. Save	
Post-Conditions	Successfully mapped	

Table 3.3 - Use Case Narratives - Manage Crew Docket Mapping

3.3.2.4 View Dashboard

Author: Akila		**Date: 06/03/2021** **Version: 1.0**
use case name:	View Dashboard	Use Case Type: □ Business □ System
use case ID:	4	
Priority:	Medium	
Source:	Metering system Dashboard	
Primary Business Actor:	Manager	
Other Participating Actors:	Administrator	
Other interested Stakeholders:	Crew Leader	
Description:	Through the dashboard manager can view the progress of the complaint handling under his/her region. He/she can also monitor the human resources and their performances along with complaint handling. He/she also be able to monitor and track physical resource management throughout the process. This process includes viewing the dashboard with given selections.	
Pre-Conditions	User need to login to the system Should attached to the relevant region	
Flow of events	1. Go to dashboard 2. Select relevant dashboard function 3. Select mandatary inputs 4. View	
Post-Conditions	Graphical and representations of the information	

Table 3.4 - Use Case Narratives - View Dashboard

3.3.2.5 View Reports

Author: Akila		**Date: 06/03/2021** **Version: 1.0**
use case name:	View Reports	Use Case Type: □ Business □ System
use case ID:	5	
Priority:	Medium	
Source:	Metering system Reports	
Primary Business Actor:	Manager	
Other Participating Actors:	Administrator	
Other interested Stakeholders:	Crew Leader	
Description:	Through the Reports manager can view the progress of the complaint handling under his/her region. He/she can also monitor the human resources and their performances along with complaint handling. He/she also be able to monitor and track physical resource management throughout the process. This process includes viewing the reports with given selections.	
Pre-Conditions	User need to login to the system Should attached to the relevant region	
Flow of events	1. Go to reports 2. Select relevant report function 3. Select mandatary inputs 4. View 5. Print / Download	
Post-Conditions	Printed statistical representations of the information	

Table 3.5 - Use Case Narratives - View Reports

3.3.2.6 Manage Crew Stocks

Author: Akila		**Date: 06/03/2021** **Version: 1.0**
use case name:	Manage Crew Stocks	Use Case Type: □ Business □ System
use case ID:	6	
Priority:	High	
Source:	Mobile app master data	
Primary Business Actor:	Crew Leader	
Other Participating Actors:		
Other interested Stakeholders:	Manager	
Description:	Each crew maintain mini stock in their vehicles. Each crew leader order the required items through the NWSDB IMS (Inventory Management System) through MR (Material Requests) and receive the requester items through MIN (Material Issue Notes). In the Meter Reader Complaint Management app crew leader can update the crew inventory using the approved MINs. This process includes Create and Update crew stocks.	
Pre-Conditions	User need to login to the App	
Flow of events	1. Go to manage stocks 2. Select add stock 3. Type MIN number 4. View stock 5. Add 6. Save	
Post-Conditions	Stock levels related to given MIN will added to crew stock	

Table 3.6 - Use Case Narratives – Manage Crew Stock

3.3.2.7 Choose Complaint

Author: Akila		**Date: 06/03/2021** **Version: 1.0**
use case name:	Choose Complaint	Use Case Type: □ Business □ System
use case ID:	7	
Priority:	High	
Source:	Mobile app main process	
Primary Business Actor:	Crew Leader	
Other Participating Actors:		
Other interested Stakeholders:	Manager	
Description:	This is the first stem of the meter reader complain management process. Main objective of this process is to select a complaint to attend. Normally complains will load according to the captured date. But the user can select the complaint according to the following factors. 1. Priority level of the complaint 2. Near location premises 3. Stock level availability However, user can select he complaint through the List view or Map view.	
Pre-Conditions	User need to login to the App	
Flow of events	1. Got to complains 2. Choose filter options 3. Choose map view or list view 4. Choose complaint	
Post-Conditions	Chooses the most appropriate complaint to attend	

Table 3.7 - Use Case Narratives - Choose Complaint

3.3.2.8 Attend Complaint

Author: Akila		**Date: 06/03/2021** **Version: 1.0**
use case name:	Attend Complaint	Use Case Type: □ Business □ System
use case ID:	8	
Priority:	High	
Source:	Mobile app main process	
Primary Business Actor:	Crew Leader	
Other Participating Actors:		
Other interested Stakeholders:	Manager	
Description:	After the specific complaint selected to attend the system will show all the necessary information such as contact details and connection details to the officer. Following functions can be call of necessary. 1. Check payment history of customer 2. Check meter reading history of the customer 3. Check complaint history of the customer 4. Use google or other navigation method to navigate to the premises.	
Pre-Conditions	User need to login to the App Chose a complaint to attuned	
Flow of events	1. Check contact details (Call to verify or notify) 2. Check complaint history 3. Check payment history 4. Check reading history 5. Use navigation to go to the destination	
Post-Conditions	Make sure that the customer is in the premises or accessible Navigate to the destination without any problem	

Table 3.8 - Use Case Narratives - Attend Complaint

3.3.2.9 Update Complaint

Author: Akila		**Date: 06/03/2021** **Version: 1.0**
use case name:	Update Complaint	Use Case Type: □ Business □ System
use case ID:	9	
Priority:	High	
Source:	Mobile app main process	
Primary Business Actor:	Crew Leader	
Other Participating Actors:	Customer	
Other interested Stakeholders:	Manager	
Description:	After the crew attend the complaint and finish the job crew leader need to update the compliant status with relevant details. This process includes following functions. 1. Enter mandatory details related to job 2. Enter used stock items for the job 3. Select participated crew members to the job 4. Ge the digital signature from the customer 5. Issue printed bill to the customer	
Pre-Conditions	User need to login to the App Job completed	
Flow of events	1. Got to job completion interface 2. Select the solution provides 3. Enter relevant data 4. Select stock used 5. Select participated employees if changed 6. Enter no of houses spend 7. Put the signature 8. Get the customer signature 9. Save 10. Print	
Post-Conditions	Successfully completed the job and update the system	

Table 3.9 - Use Case Narratives - Update Complaint

3.3.3 Sequence Diagram

Following (Figure 3.4 to Figure 3.14) are the Sequence Diagrams for all the major processes

3.3.3.1 Manage Crew Details

Create Crew

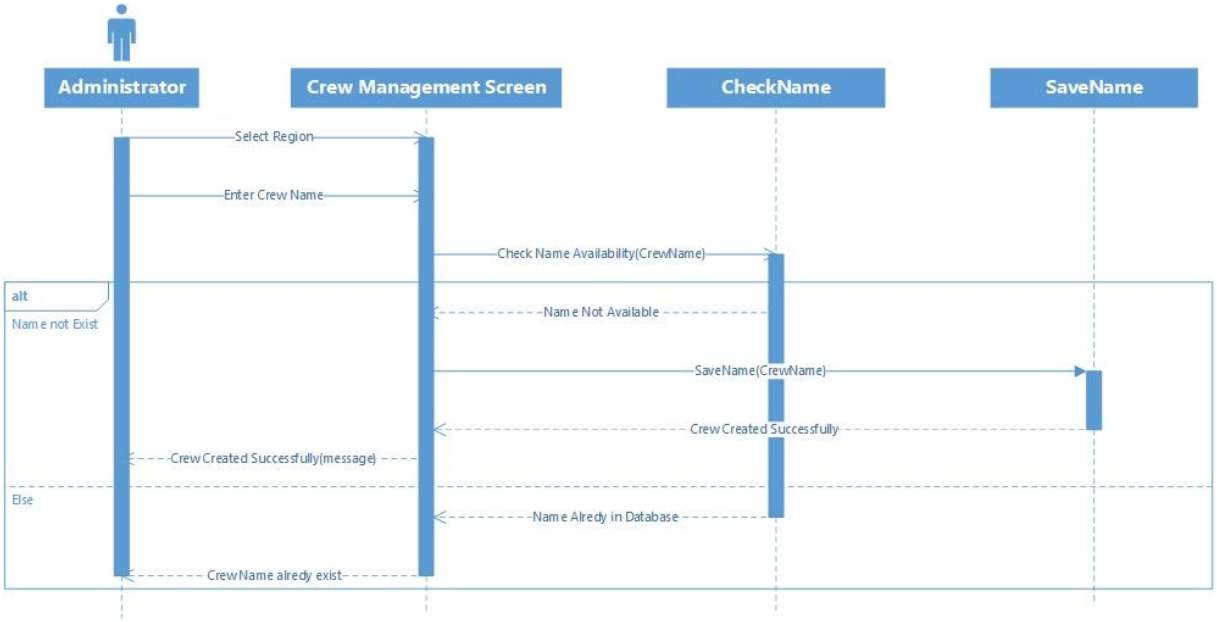


Figure 3.4 - Sequence Diagram - Create Crew

Update Crew

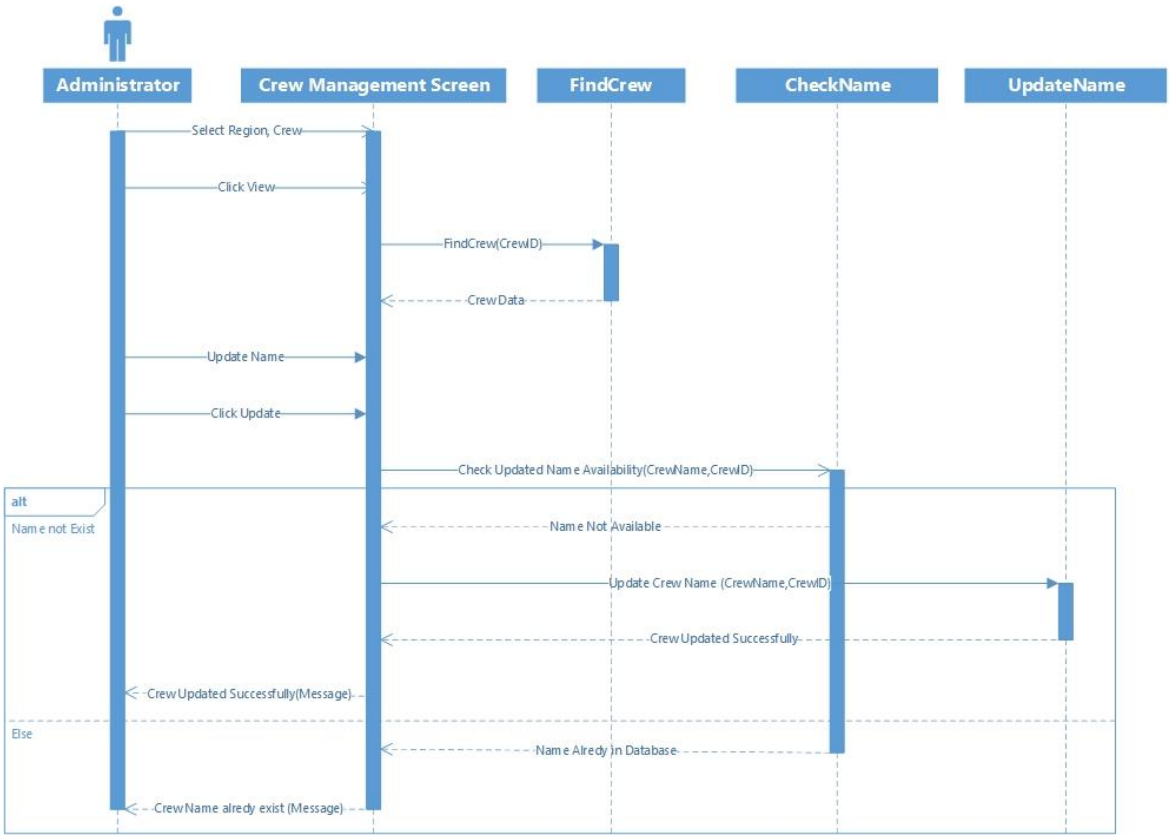


Figure 3.5 - Sequence Diagram - Update Crew

Delete Crew

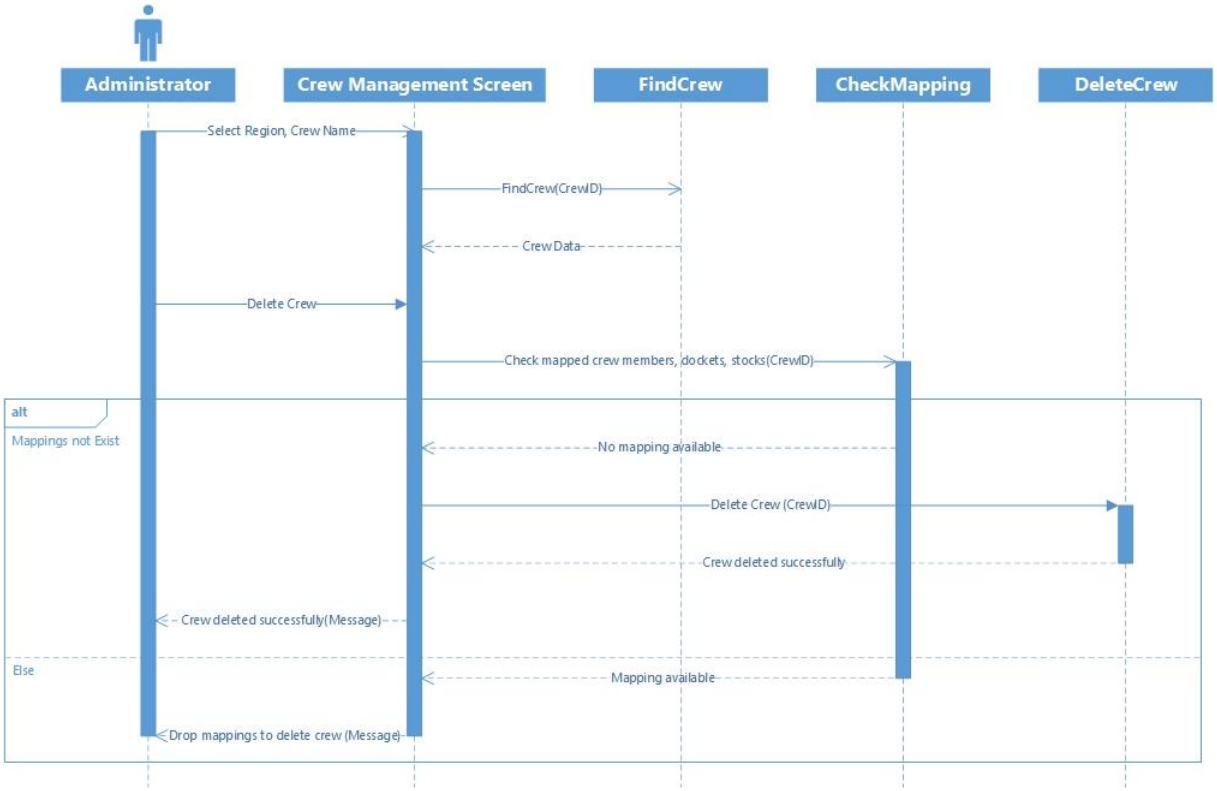


Figure 3.6 - Sequence Diagram - Delete Crew

3.3.3.2 Manage Crew Member Details

Create Crew Member

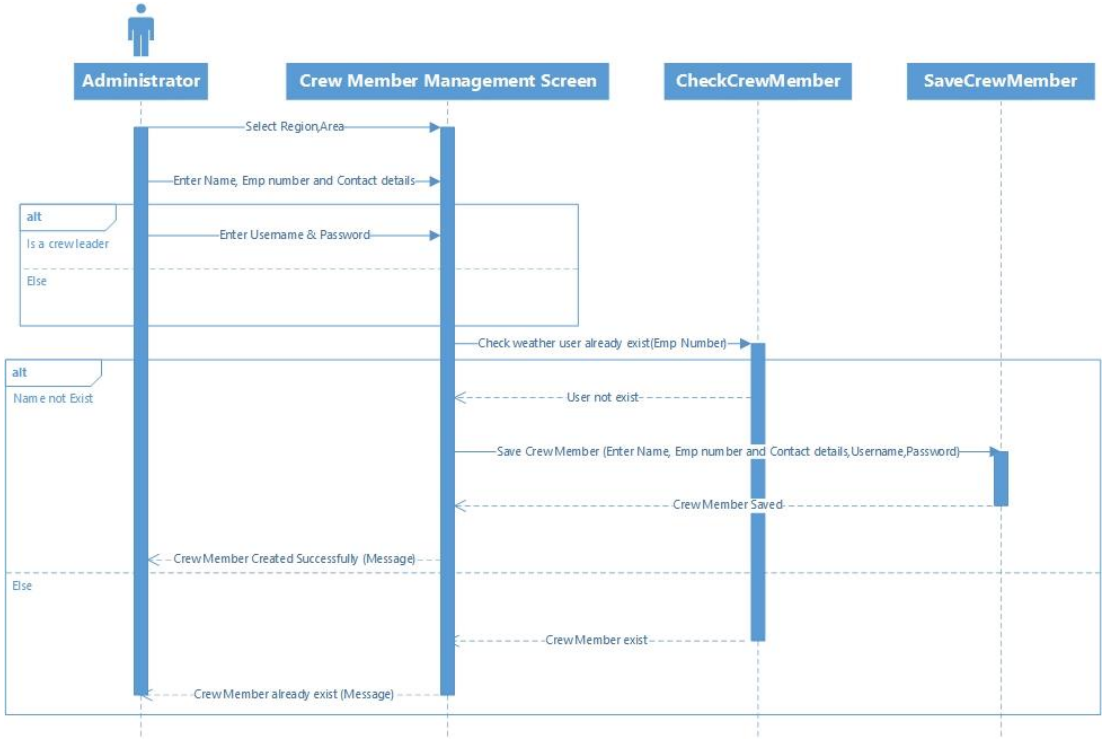


Figure 3.7 - Sequence Diagram - Create Crew Member

Update Crew Member

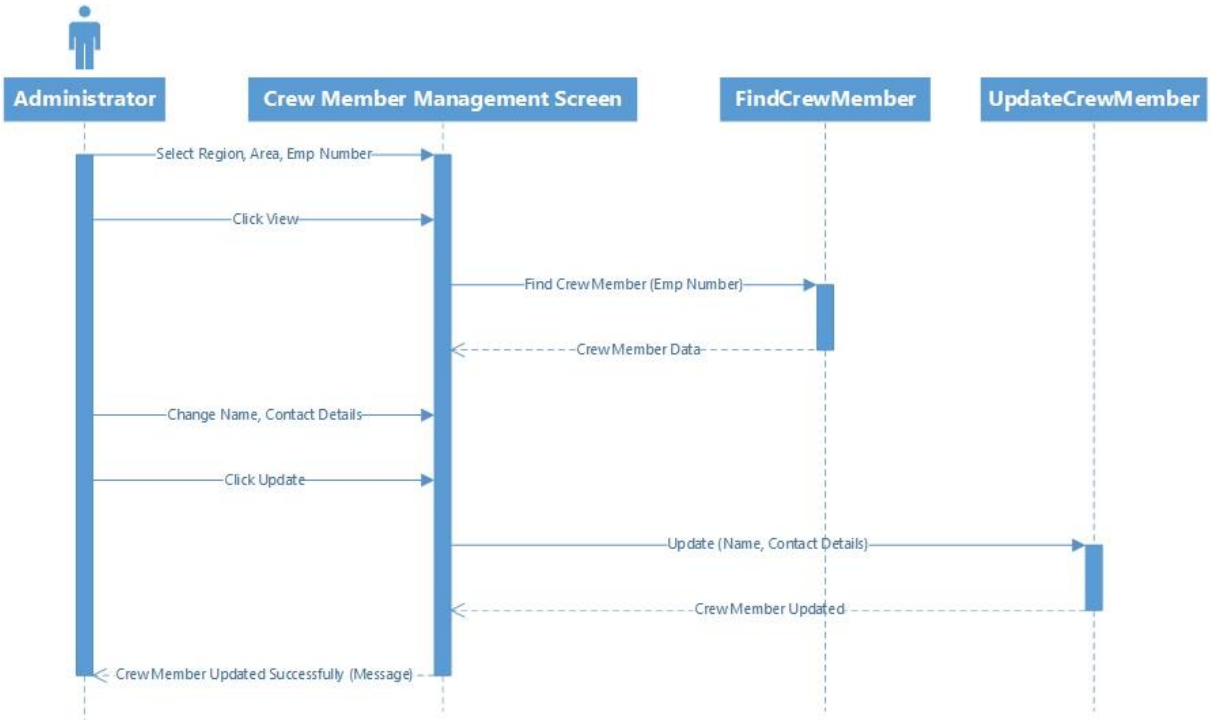


Figure 3.8 - Sequence Diagram - Update Crew Member

Delete Crew Member

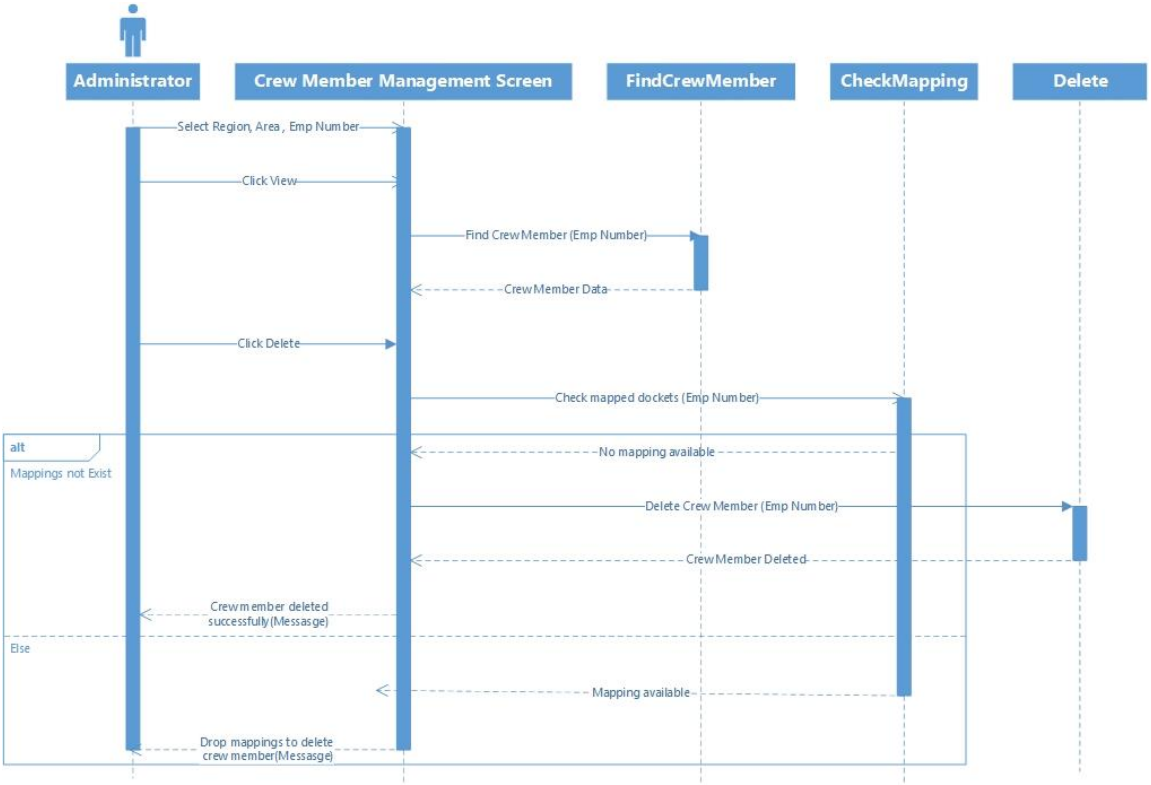


Figure 3.9 - Sequence Diagram - Delete Crew Member

3.3.3.3 Manage Crew Docket Mapping

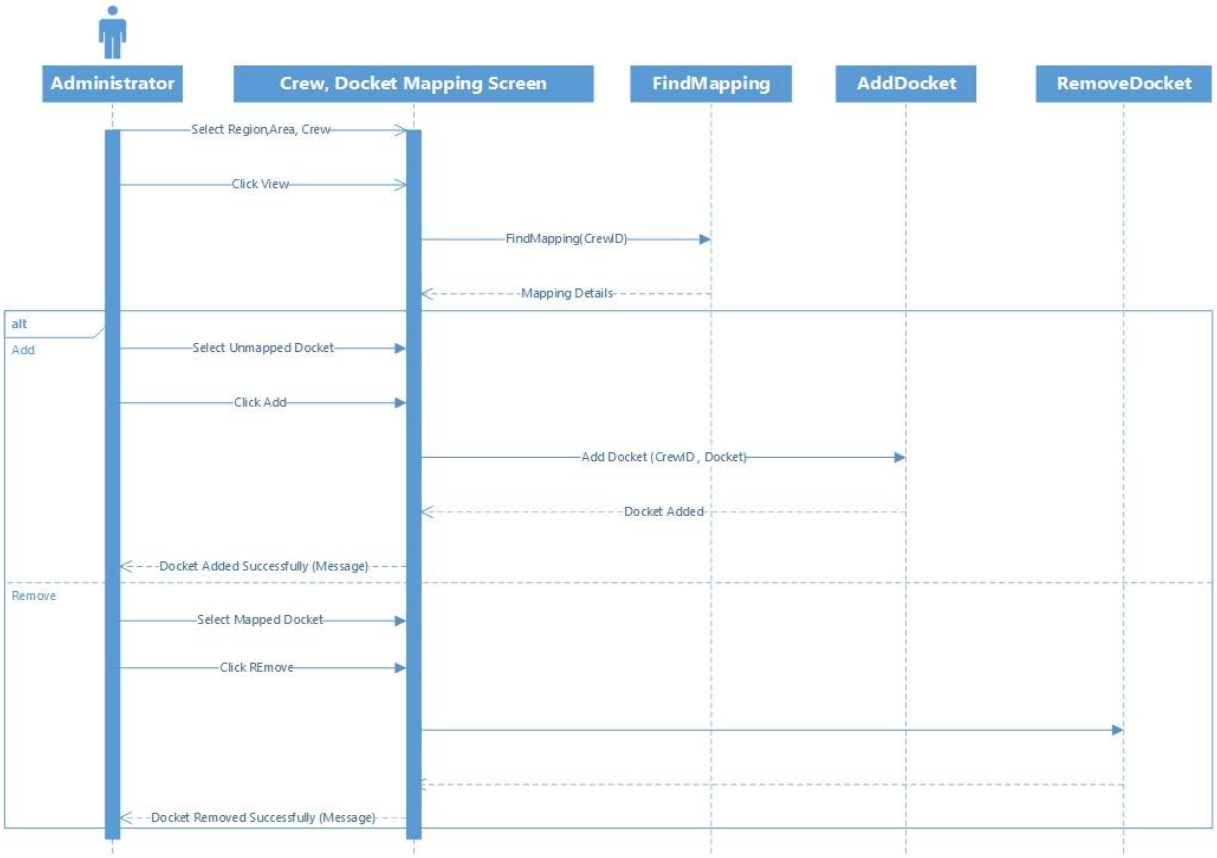


Figure 3.10 - Sequence Diagram - Manage Crew Docket Mapping

3.3.3.4 Check Available Stocks

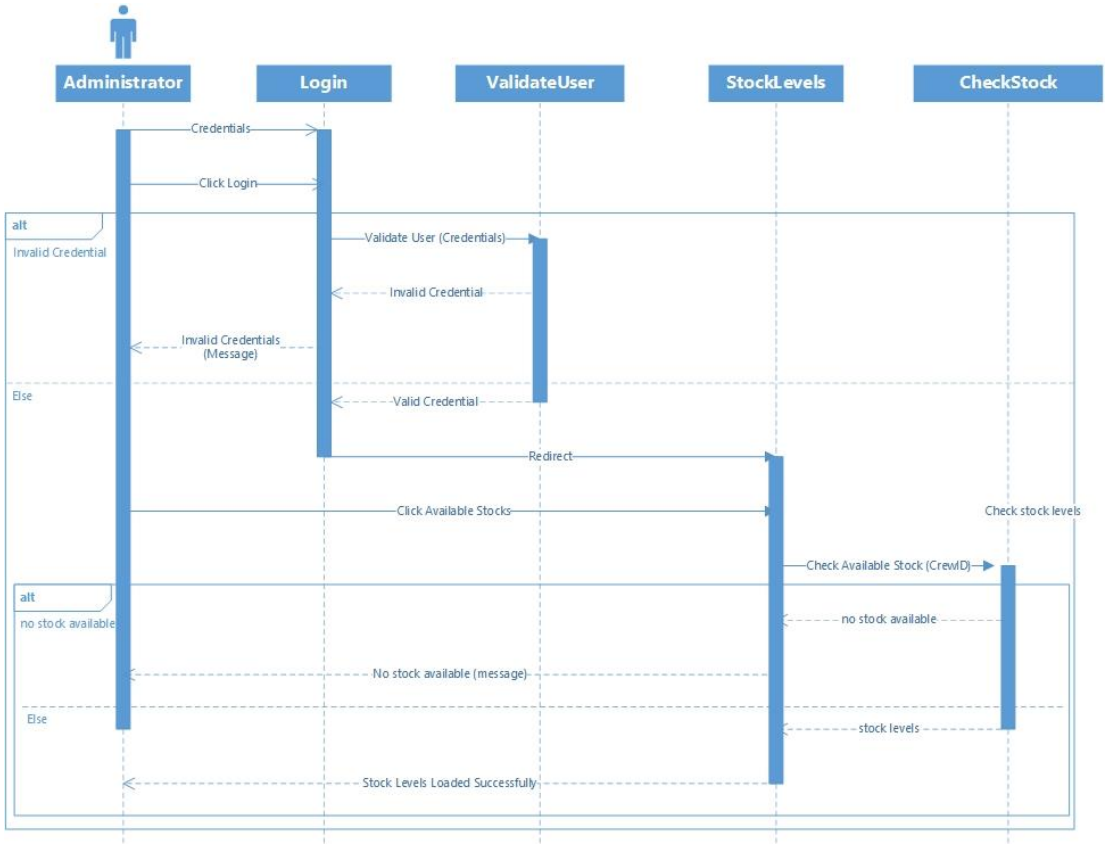


Figure 3.11 - Sequence Diagram - Check Available Stocks

3.3.3.5 Manage Crew Stocks

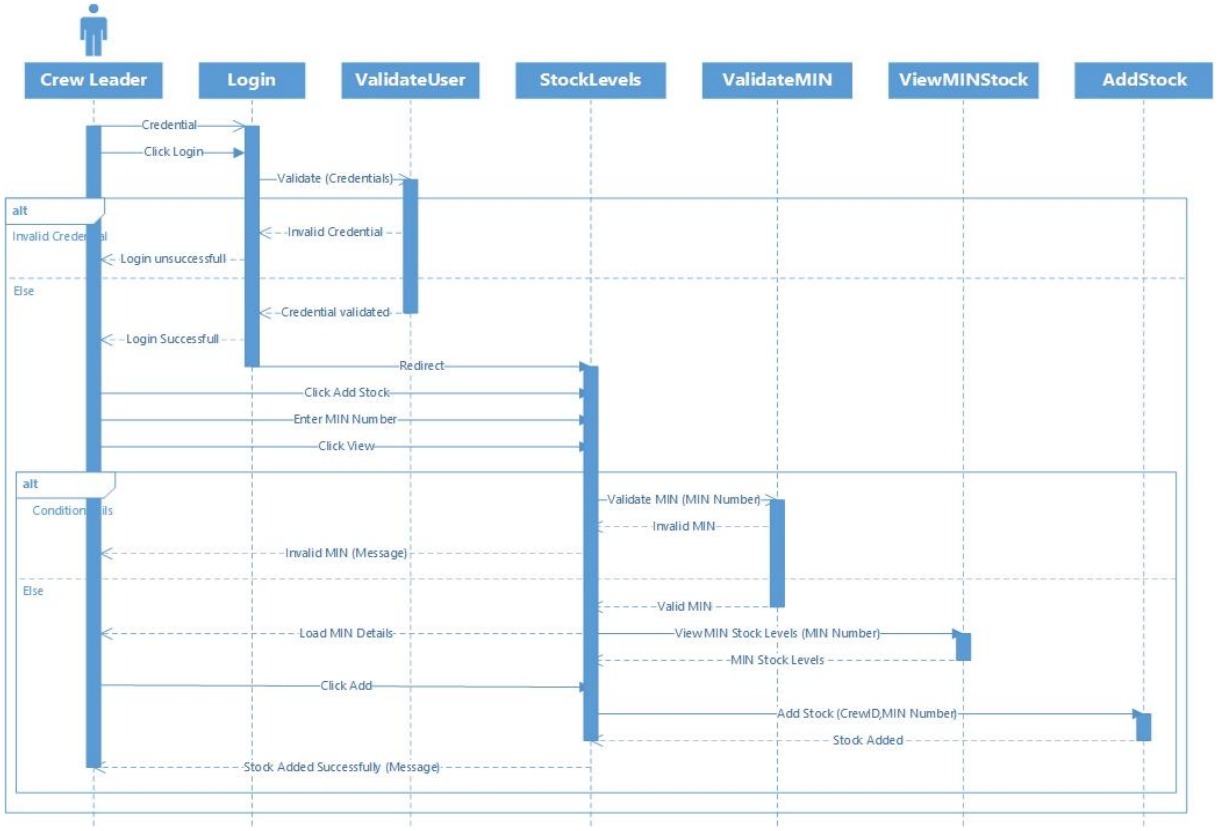


Figure 3.12 - Sequence Diagram - Manage Crew Stocks

3.3.3.6 Choose Complaint

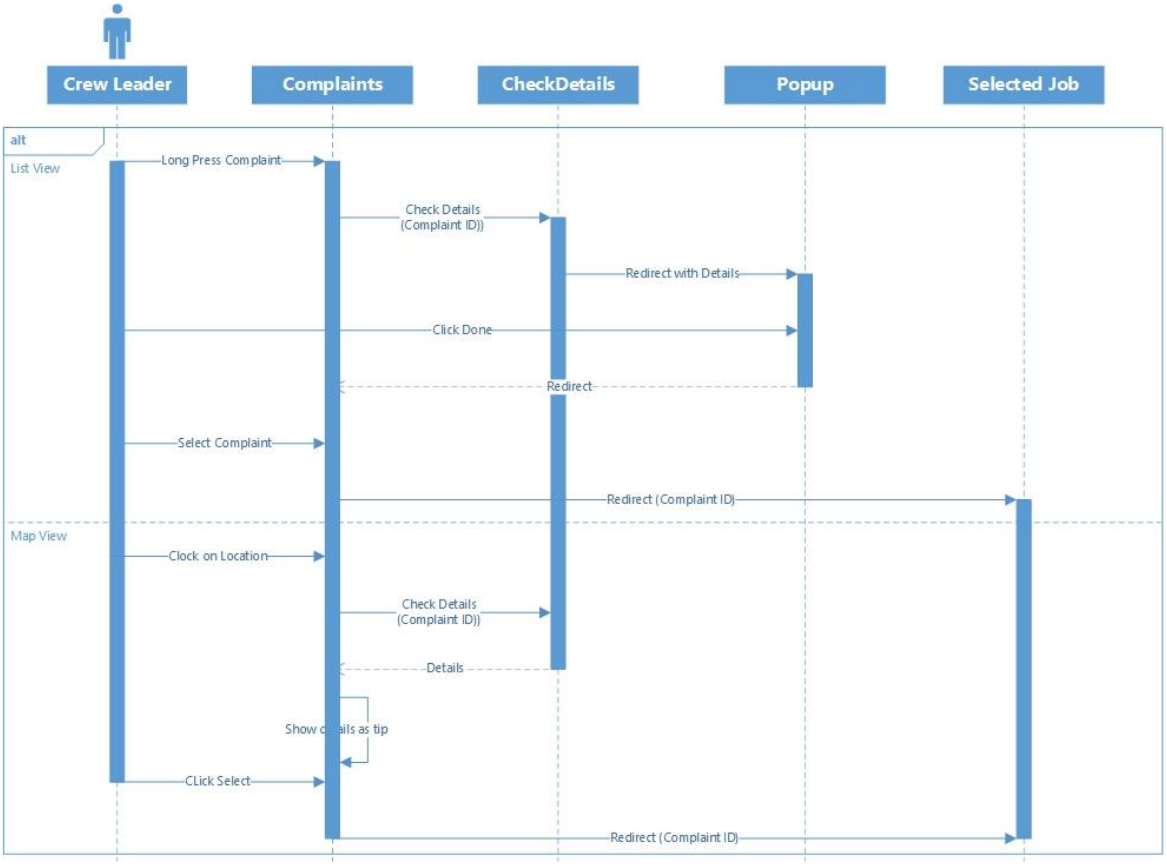


Figure 3.13 - Sequence Diagram – Choose Complaint

3.3.3.7 Update Complaint

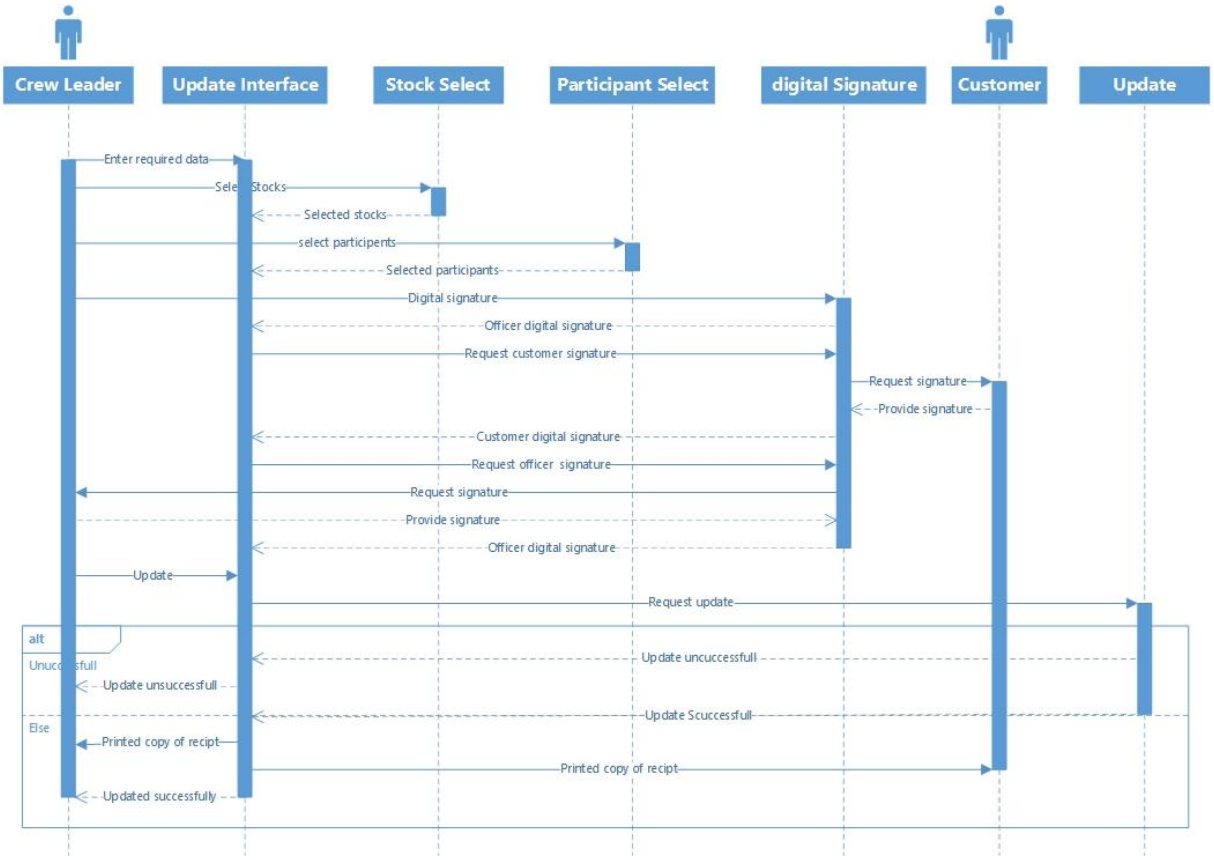


Figure 3.14 - Sequence Diagram – Update Complaint

3.3.4 Class Diagram

A class diagram is a structural diagram. This represents the static structure of the program. Class diagram shows that classes and their attributes and operations. It also represents the relationships among the classes (paradigm, 2020).

The figure (Figure 3.15) shows the class diagram of the proposed system

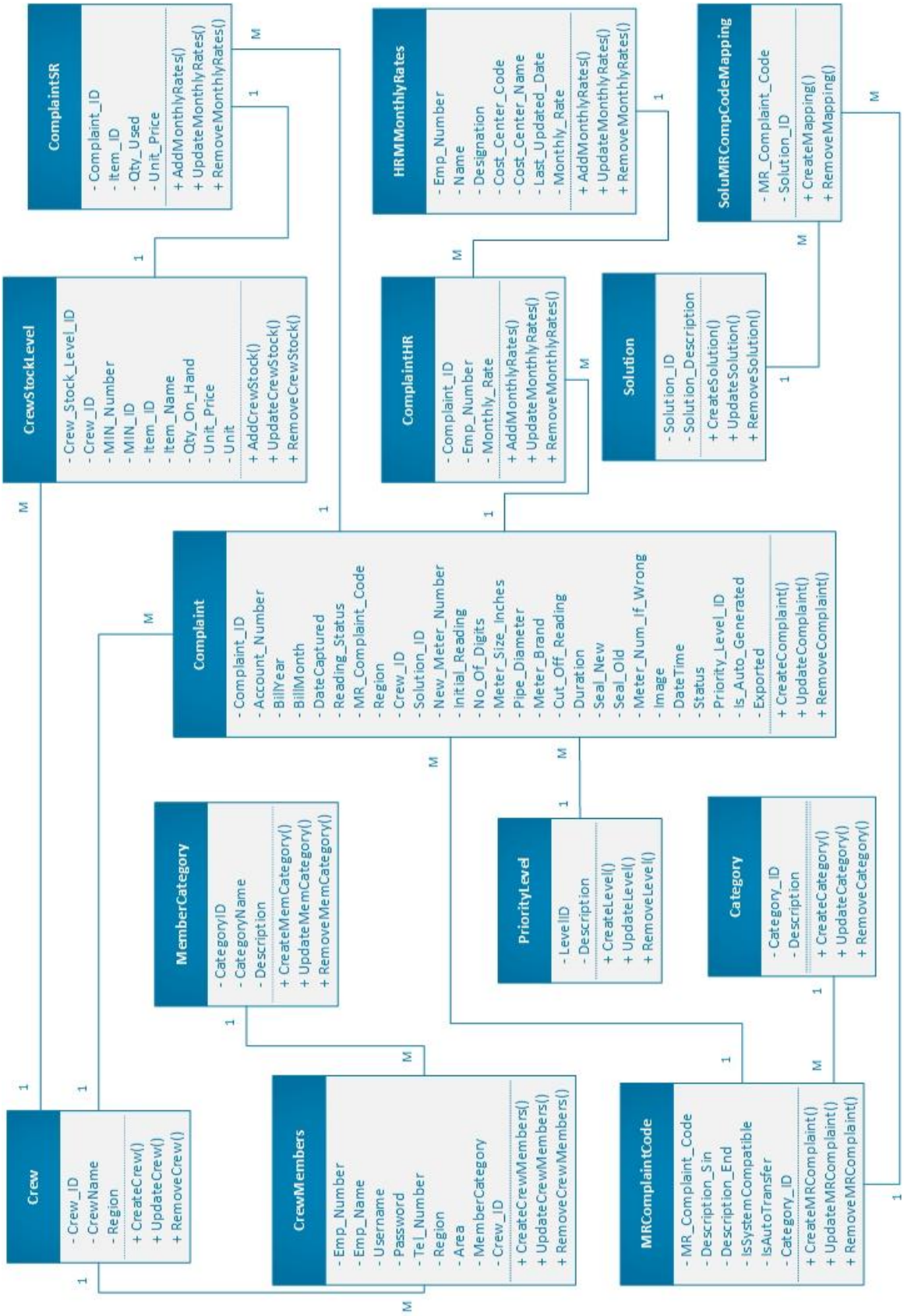


Figure 3.15 - Class Diagram

Chapter 4: Methodology

4.1 Introduction

The Methodology phase of the system is the most important part of the project development. It describes the implementation environment, related technologies and tools, modules of the proposed system and their interactions. Also describes the selected technologies and tools. It can also be used to give clients a clear idea of the project during the development phase.

4.2 System implementation environment

4.2.1 Hardware environment

This table (Table 4.1) describe the Hardware configurations of the development environment

Specification	Justification
Device Type – HP Laptop	To provide required processing power to run the development process smoothly
Processor - Intel(R) Core (TM) i7-6500U CPU @ 2.50GHz	
RAM - 16.0 GB	Android studio require huge ran in runtime
Display Device – Intel® HD Graphic 520	To support development software to run smoothly
Display total memory – 8268 MB	
Display Mode – 1920 * 1080 (32 bit)	
Storage Size – 500GB	To install all the required software

Table 4.1 - Hardware environment

4.2.2 Software environment

This table (Table 4.2) describe the Hardware configurations of the development environment

Specification	Justification
Windows edition - Windows 10 Pro	Latest stable available version and support all relevant software
Android Studio – version 4.2.1	Stable latest version
MS SQL – MS SQL 2014	Latest licensed version that NWSDB has
MS Visual Studio - VS 2015	Latest licensed version that NWSDB has
Photoshop – CS5	has all the required tools

Table 4.2 - Software environment

4.3 Related Technologies

Related technologies can be described under three categories Development, Server and Client

4.3.1 Development

Here are the technologies that are related to development of the solution

- Microsoft Windows 10

  Windows 10 is a latest operating system of series of operating systems developed by Microsoft as part of the Windows NT family of operating systems.

- Dot Net frame work 4.5

  The .NET Framework is software developed by Microsoft and works primarily on Microsoft Windows. It includes a large class library called the Framework Class Library, which provides language interaction in many programming languages.

- Visual Studio

  Microsoft Visual Studio is an integrated development environment for Microsoft. It is used to develop computer applications, websites, web applications, web services and mobile applications.

- Android Studio

  Android Studio is the official integrated development environment of Google's Android operating system, based on JetBrains 'IntelliJ IDEA software and specifically designed for Android development.

4.3.2 Server

Here are the technologies that are related to server that needed to implement the solution

- Microsoft Windows Server 2012

  Windows Server 2012 is the fifth version of Microsoft's Windows Server operating system, which is part of the Windows NT family of operating systems.

- IIS web server

  The Internet Information Service is a scalable web server software developed by Microsoft for use in the Windows NT family.

- MS SQL 2014

  Microsoft SQL Server is a communications database management system developed by Microsoft. For a database server, it is a software product that has the primary responsibility for storing and retrieving data at the request of other software.

4.3.3 Client

Here are the technologies that are related to clients those who use the solution

- Android OS 6.0 or above

  Android is a mobile operating system based on a modified version of the Linux kernel and other open source programs, and is typically designed for touch-sensitive mobile devices such as smartphones and tablets.

- Google maps

  Google Maps is a web mapping service developed by Google. Offers satellite imagery, aerial photography, road maps and 360 ° interactive panoramic views of the roads.

- Microsoft Windows 7 or above

  Windows 7 is an operating system developed by Microsoft and part of the Windows NT family. Released July 22, 2009.

- Web browser – Internet Explorer/Microsoft Edge, Firefox, Google chrome

  A web browser is a software application that accesses information about the World Wide Web. When a user wants to retrieve a website from a website, the browser downloads the necessary content from the web server and displays the page on the user's device.

4.4 Module Structure

There are 6 major module that interact together in this proposed system. All these module work together to achieve the complaint handling process.

4.4.1 Modules

Following are the major modules in proposed system (Figure 4.1)

Figure 4.1 - Modules

4.4.2 Modules Interaction

All the module interacts together to manage the complaint (Figure 4.2)

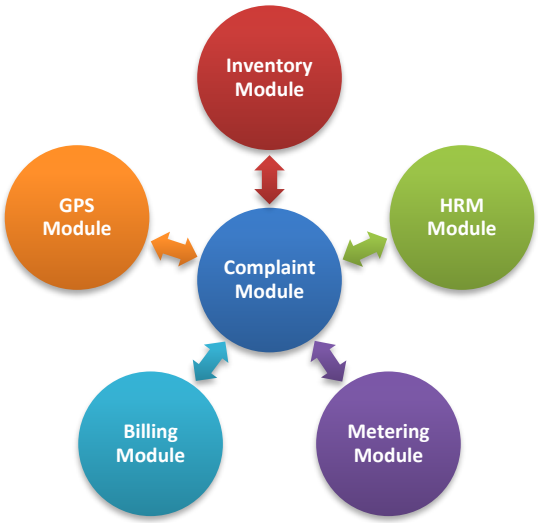


Figure 4.2 - Modules Interaction

4.5 Major Codes

Coding can be divided into five categories

1. ASP.NET – Web Services / Web based solution
2. SQL Scripting – SQL Database
3. Android Development – Android studio
4. SQLite Scripting – Android Database

4.5.1 ASP.NET

In this project ASP.NET has major area to cover. All the Services that used in the mobile app are developed using ASP.NET language. Those services are developed by following the Web Service Architecture using Visual Studio 2015. Here is the structure of the Service development (Figure 4.3).

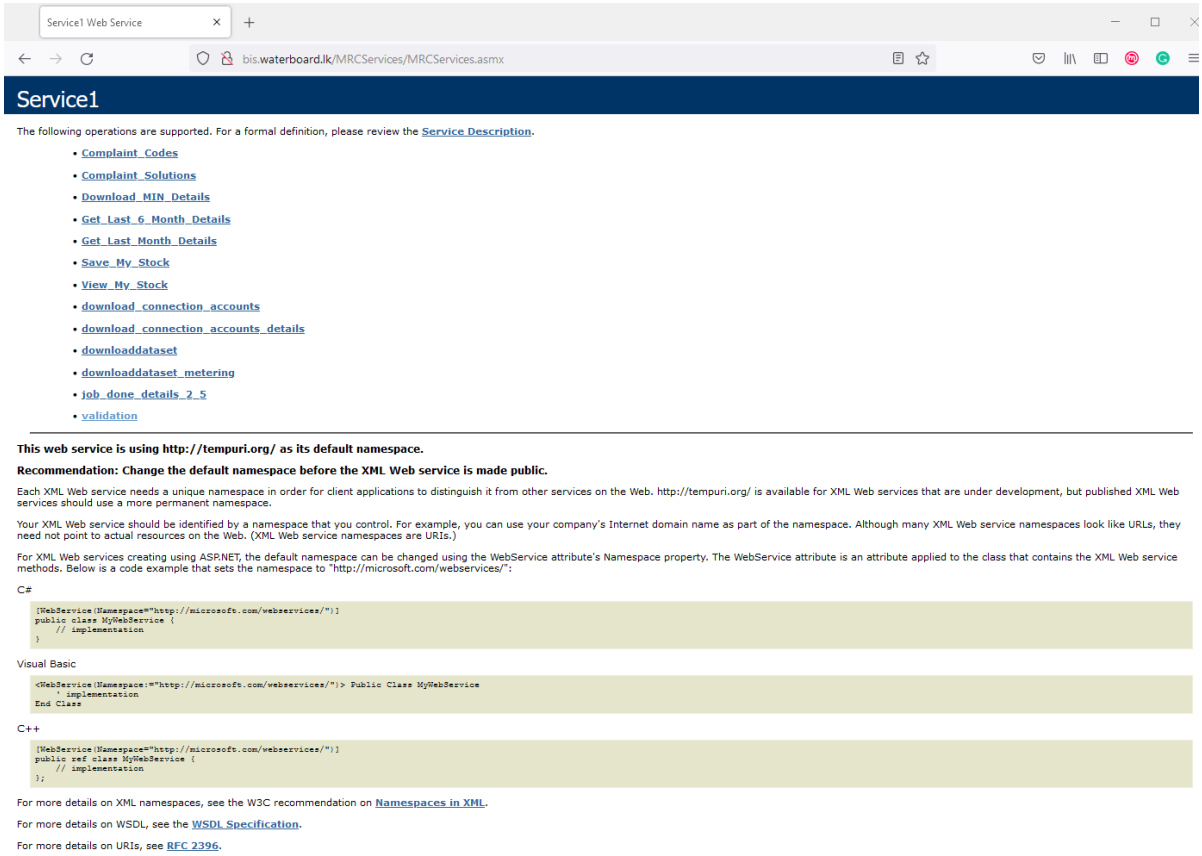


Figure 4.3 - Web Service structure

Here is web service coding (Figure 4.4) that use to Check available stocks

```
[WebMethod]
0 references
public string View_My_Stock(string User_ID)
{
    string json = "";
    DataTable dt = new DataTable();
    SqlConnection myConn = new SqlConnection();
    myConn.ConnectionString = ConfigurationManager.ConnectionStrings["ConnectionString"].ToString();
    SqlCommand MyCommand = new SqlCommand("", myConn);
    MyCommand.CommandText = "select Item_Name,Qty_On_Hand,Unit_Price from CrewMemberStockLevels where Emp_Number = " + User_ID + " order by Item_ID";
    myConn.Open();
    SqlDataReader MyReader = MyCommand.ExecuteReader();
    if (MyReader.Read())
    {
        MyReader.Close();
        MyReader.Dispose();
        SqlDataAdapter myadapter = new SqlDataAdapter(MyCommand);
        myadapter.Fill(dt);
        json = JsonConvert.SerializeObject(dt, Formatting.Indented);
    }
    else
    {
        MyReader.Close();
        MyReader.Dispose();
        json = "No Stock Available !";
    }
    myConn.Close();
    myConn.Dispose();
    return (json);
}
```

Figure 4.4 - Web Service to check available stocks

4.5.2 SQL Scripting

Here is the database diagram (Figure 4.5) of the proposed system SQL database

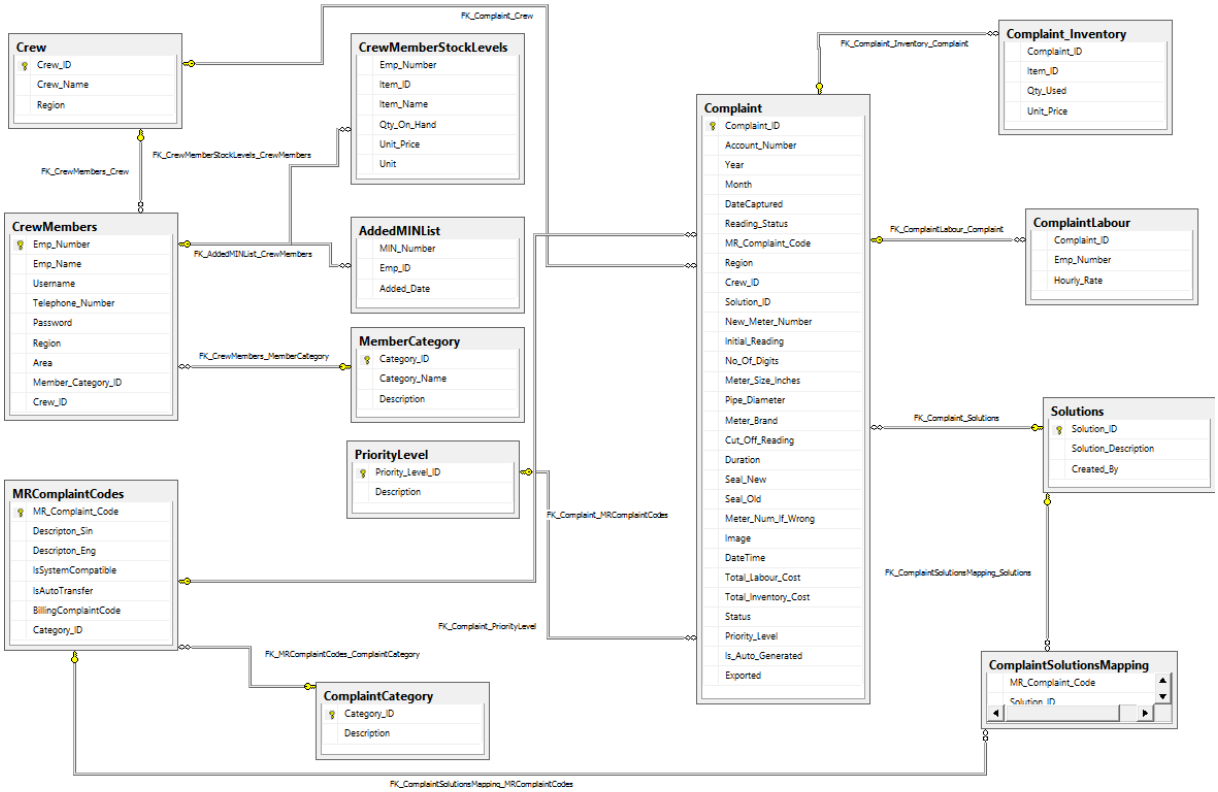


Figure 4.5 - Database diagram

Chapter 5: Testing and Evaluation

5.1 Introduction

In testing and evaluation phase, the project is then evaluated according to the user-defined functional requirements. this will ensure that the project meets the needs of the client by addressing the issues mentioned at the beginning. In addition, system performance and robustness will be discussed. This includes monitoring, testing and system maintenance.

5.2 Proposed System Testing Methodology

In proposed system the testing process conducted under three main categories.

- Functional Testing
- Non-Functional Testing
- Maintenance Testing

Here those testing process had to conduct in both Mobile application and the web-based system. For each testing categories following testing types (Figure 5.1) are used.

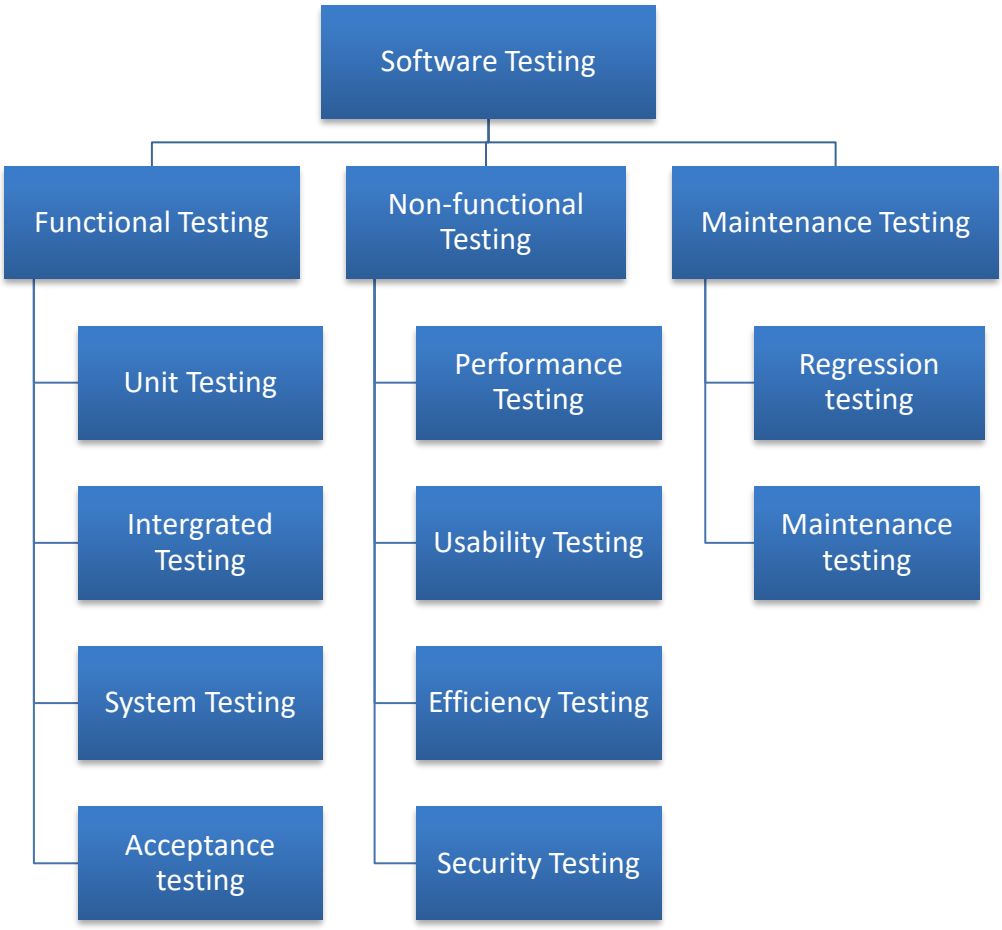


Figure 5. 1 - System Testing Types

5.3 Functional Testing

Under the functional testing process the testing phase was conducted according to a test plan. Testing plan used to get a sound idea of the weight of the testing phase and order each function according to the priority. Then develop test cases for each function and report them for further use.

5.3.1 Test Plan

For this system, a test plan that covers the system was developed and a specific approach to project testing was developed. Followings are the objectives of developed test plan. (guru99, 2021)

- Develop a comprehensive test plan that describes the nature and scope of the tests that are deemed necessary to achieve the project's test objectives, including software and hardware requirements.
- Organize an orderly agenda of activities, identify equipment and organizational provisions, define test methods and strategies to be used, and determine what to deliver.

Here (Table 5.1) is the test Plan for Meter reader complaint management app login control

	Function	Testing Procedure	Expected Output	Propriety
Login Control (Mobile App)				
01	Login to the app without registered into 'Metering' system	Insert credentials that not registered in system	Worn the user as Invalid user	High
02	Login to the system without Username or Password	Do not insert any credentials	Ask to enter Username and Password	Medium
03	Login to the system without Username	Insert Password only	Ask to enter Username	Medium
04	Login to the system without Password	Insert Username only	Ask to enter Password	Medium
05	Login to the system with incorrect credentials	Insert incorrect credentials	Worn the user as Incorrect credentials	High
06	Login to the system with correct credentials	Insert Correct credentials	Login to the system with welcome message	High

Table 5. 1 - Login control test plan

Here (Table 5.2) is the test Plan for Meter reader complaint management app to Update crew stock levels using MIN number.

	Function	Testing Procedure	Expected Output	Propriety
Update crew stock levels control (Mobile App)				
01	Add stock without MIN number	Do not insert MIN number	Ask to enter MIN number	Medium
02	Add stock with incorrect MIN number	Insert incorrect MIN number	Worn the user as Incorrect MIN number	High
03	Add stock with already added MIN number	Insert MIN number already added	Worn the user as MIN already added	Medium
04	Add stock with not approved MIN number	Insert not approved MIN number	Worn the user as MIN not approved	Medium
05	Add stock with incorrect cost center MIN number	Insert MIN number in different cost code	Worn the user as Cost code mismatch	High
06	Add stock with correct MIN number	Insert correct MIN number	Add MIN stock to available stock	High

Table 5. 2 - Update crew stock levels control test plan

Here (Table 5.3) is the test Plan for Metering web-based system create crew control.

	Function	Testing Procedure	Expected Output	Propriety
Logging Control (Metering System)				
01	Create crew without name	Do not insert crew name	Ask to enter crew name	Medium
02	Create crew with already exist name	Insert already captured crew name	Worn the user as Crew already exist	High
03	Create crew with suitable name	Insert suitable crew name	Crew successfully created message	Medium

Table 5. 3 - Create crew control test plan

Here (Table 5.4) is the test Plan for Metering web-based system Crew docket mapping control.

	Function	Testing Procedure	Expected Output	Propriety
Crew docket mapping control (Metering System)				
01	Search without Crew selected	Click Search without selecting crew	Ask to select crew	Medium
02	Search with Crew selected	Click Search after selecting crew	Show available dockets bucket and the added docket buckets with Add, Remove and Done buttons. Disable the save button	Medium
03	Add / Remove without selecting docket	Click Add or Remove buttons without selecting docket	Worn the user as select docket to add or remove	Medium
04	Add Docket to Added dockets bucket	Select docket from available dockets bucket and click Add button	Remove selected docket from available dockets bucket and appear it in added dockets bucket	High
05	Remove docket from added dockets bucket	Select docket from added dockets bucket and click Remove button	Remove selected docket from added dockets bucket and appear it in available dockets bucket	High
06	Done	Click Done button	Disappear docket buckets. Enable search button	Medium

Table 5. 4 - Crew Docket Mapping Control test plan

5.3.2 Test Cases

After developing the test plan then it is required to initiate the testing process according to the plan. Each function in the test plan can be a single test case. But here are few examples of test case that generated under one test plan segment. Following are the Test case for the test plan "Metering web-based system Crew docket mapping control" which showed in Table 5.4

Here in Table 5.5 is the test case for Search without Crew selected function in Crew docket mapping control module (Rajkumar, 2020)

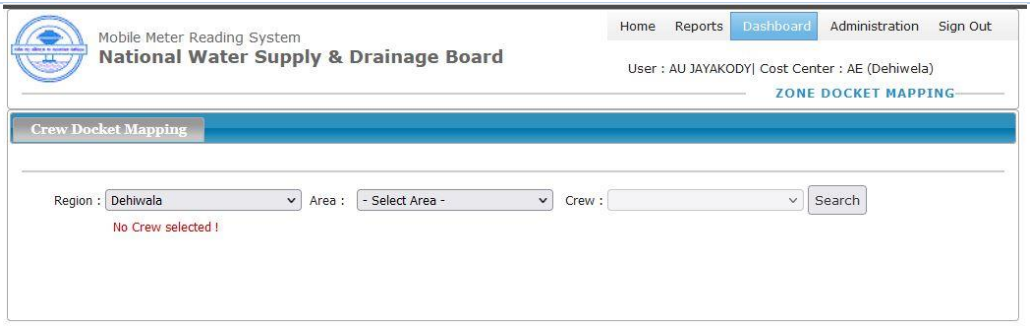
Test case ID	01
Tested Component	Crew docket mapping
Module Name	Crew docket mapping control
Test Case	Search without Crew selected
Expected Output	Ask to select crew
Actual output	**Status**
	Pass

Table 5. 5 - Search without Crew selected Test Case

Here in Table 5.6 is the test case for Search without Crew selected function in Crew docket mapping control module

Test case ID	02
Tested Component	Crew docket mapping
Module Name	Crew docket mapping control
Test Case	Search with Crew selected
Expected Output	Show available dockets bucket and the added docket buckets with Add, Remove and Done buttons.

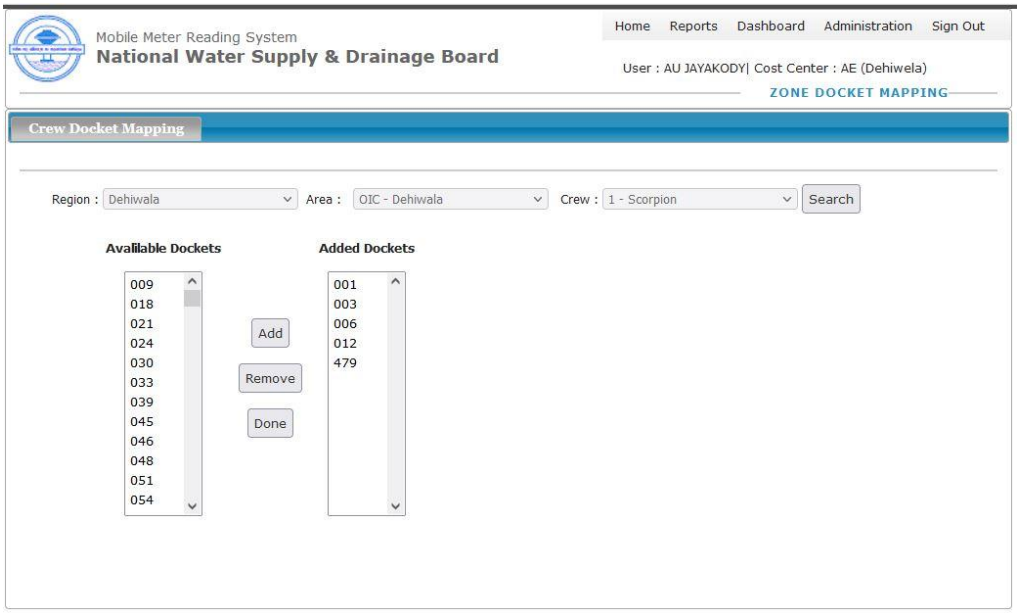
Actual output	**Status**
	Pass

Table 5. 6 - Search with Crew selected Test Case

Here in Table 5.7 is the test case for Add / Remove without selecting docket function in Crew docket mapping control module

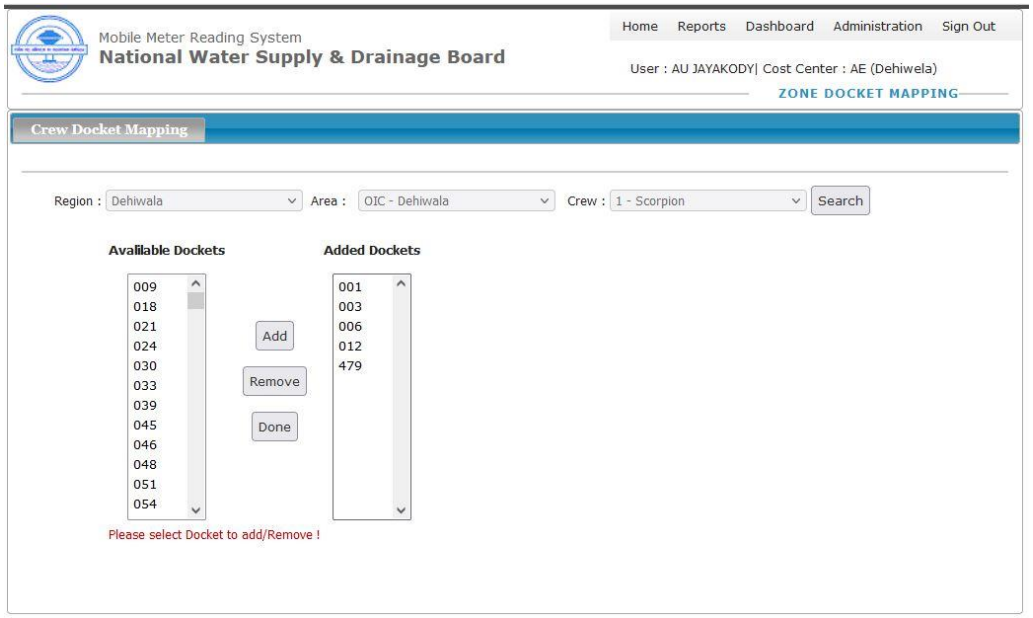
Test case ID	03	
Tested Component	Crew docket mapping	
Module Name	Crew docket mapping control	
Test Case	Add / Remove without selecting docket	
Expected Output	Warn the user as select docket to add or remove	
Actual output		**Status**
		Pass

Table 5. 7 - Search with Crew selected Test Case

Here in Table 5.8 is the test case for Add Docket to Added dockets bucket function in Crew docket mapping control module

Test case ID	04
Tested Component	Crew docket mapping
Module Name	Crew docket mapping control
Test Case	Add Docket to Added dockets bucket
Expected Output	Remove selected docket from available dockets bucket and appear it in added dockets bucket

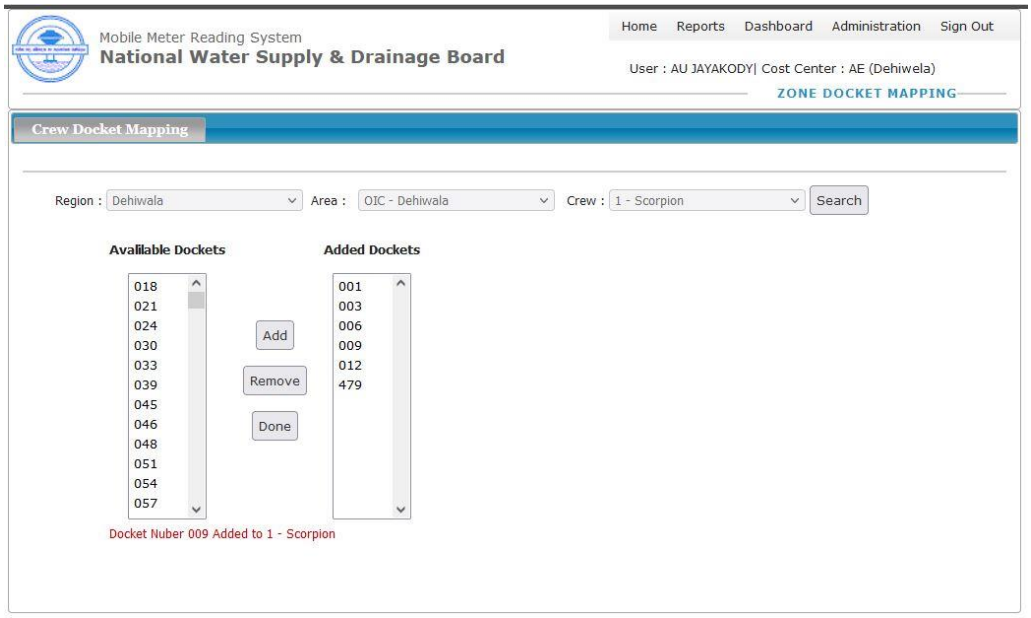
Actual output	**Status**
	Pass

Table 5. 8 - Add Docket to Added dockets bucket test case

Here in Table 5.9 is the test case for Remove docket from added dockets bucket function in Crew docket mapping control module

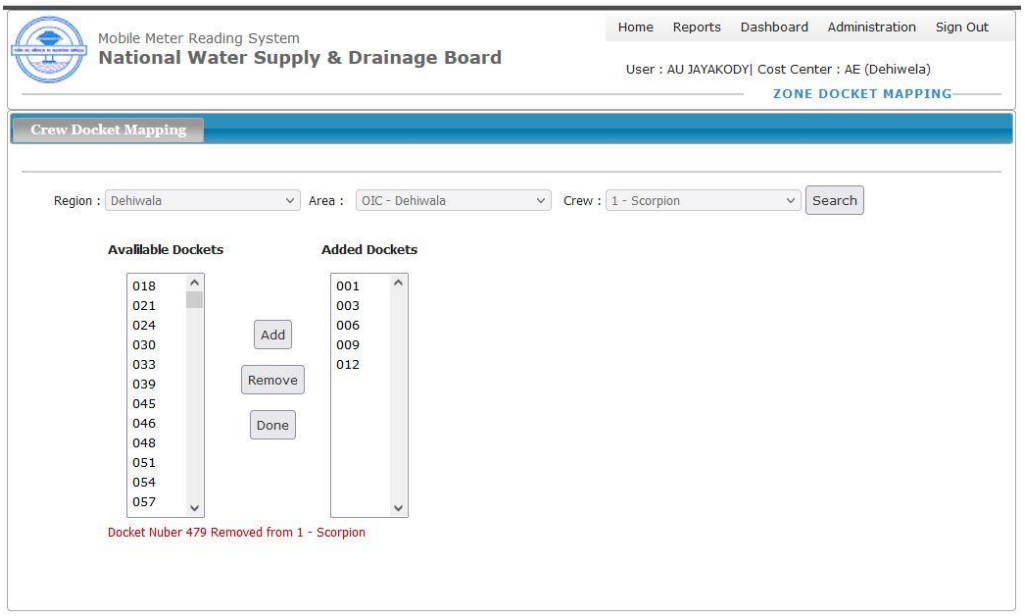
Test case ID	05	
Tested Component	Crew docket mapping	
Module Name	Crew docket mapping control	
Test Case	Remove docket from added dockets bucket	
Expected Output	Remove selected docket from added dockets bucket and appear it in available dockets bucket	
Actual output		**Status**
		Pass

Table 5. 9 - Remove docket from added dockets bucket Test Case

Here in Table 5.10 is the test case for Click Done button function in Crew docket mapping control module

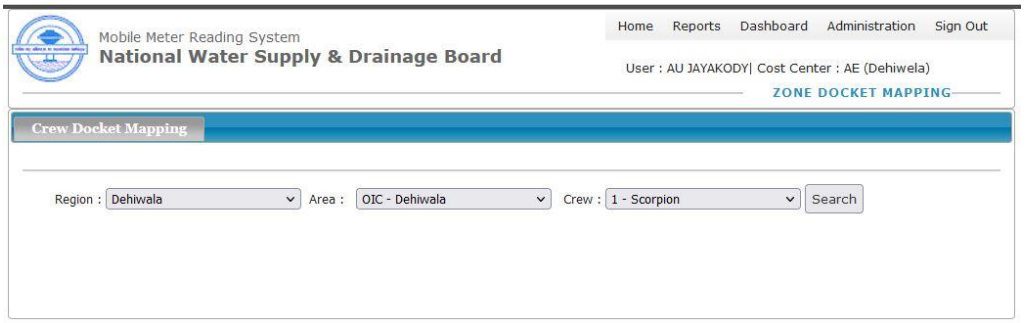
Test case ID	06
Tested Component	Crew docket mapping
Module Name	Crew docket mapping control
Test Case	Click Done button
Expected Output	Disappear docket buckets. Enable search button
Actual output	**Status**
	Pass

Table 5. 10 - Click Done button Test Case

5.4 Non-Functional Testing

Non-functional testing was conducted under following test types. (www.softwaretestinghelp.com, 2020)

5.4.1 Performance Testing

Performance testing was conducted for the Mobile application under following subject areas.

- App Start-Up

Use special launching command that launch the app, measure the time to start up, terminate the process and continue the process 100 times and calculate the average start up time and output. The best time it recorded was 1131 ms.

- Battery Time while using an app

This is an online app, so app need to connect to the internet all the time to use. We use Samsung galaxy tab a for testing the app. It has Li-Po 5100 mAh battery. In average, this app can run with its routine works for two days with a single charge.

- Usage with Other Apps

Meter reader complaint management app need to work along with goggle maps or other similar online or offline map applications to continue its work. This app work fine with google maps and third-party map applications smoothly without any problem.

- Memory Consumption

Initial size of the .apk file is 25 MB and after installation it takes 100 MB space.

- App in background

There are two times that app run in background,

  - ✓ Routing to the location with google maps
  - ✓ Taking a photo with phone camera

Both of the situations are handled perfectly by app without any data or state lost.

5.4.2 Usability Testing

Usability testing was conducted under following three categories.

- In person usability testing

Registered into system as dummy user and go through the whole complaint management process in person and test the system for usability. Then use one actual user (OIC Maligakanda) and test the application in actual environment for 5 complain management activities and observe the scenario and identify the usability issues.

- Monitored remote usability testing

Selected 5 users who were selected and install the application in their own android devices and ask them to work parallelly using the app and their manual process. Their progress was monitors remotely via metering application and the database logs.

- Unmonitored remote usability testing

Finally, the system was installed and configured to all the crew leaders in the Maligakanda office and gather their comments using the questioner and analysed them for better understanding of the system usability. The relevant analysis is explained under evaluation topic.

5.4.3 Security Testing

Security testing was conduct for the following instances

Mobile app

- Login to the app with username and password
- View the jobs only relate to specific crew
- Only use the inventory items that are under relevant crew
- Add the inventory items to the crew stock only using genuine MINs
- View only the relevant personal information's of the customers
- Change the phone date to change the job done date

Web based system

- Login to the system with username and password
- Can manage crew/users/dockets details only under login region
- Can manage mobile app behaviours as necessary

5.5 Maintenance Testing

Following maintenances testing was carried out in testing period. (Rajkumar, 2021)

5.5.1 Regression Testing

Regression testing was conducted to make sure the miner modification that have done after the functional and non-functional testing are correct and solve the problems that occurred. This testing also certifies that modification that have done do not affect the other parts of the system.

When undergoing the regression retesting specific technique called 'Regression Test Selection' was used to conduct the testing. Reason to select this technique is that found errors requires only minor modifications. In 'Regression Test Selection' technique only re test the selected set of test cases again not all the test cases.

5.5.2 Maintenance Testing

After implementing the solution maintenance testing process conducted at one situation.

After one week of implementation is completed in the Maligawatta area users are request to change the main colour of the mobile application interface to adopt the colour fluctuation in the

physical environment. The situation controlled by changing the brightness of the interface main colour and replacing glossy tempered glasses with mat tempered glasses.

However, this situation leads to conduct a maintenance testing process in the project.

5.6 User Evaluation

User evaluation has conducted for mobile application. To complete this phase questionnaires are used to gather user evaluations from the users. Because of the current situation in Sri Lanka user evaluations are collected via google forms and then analyze.

The software engineering model used in this project was the RAD model, so the evaluation of each delivery was obtained at the time of delivery of each component. These were mainly review meetings and the feedback received that ware used for modifications.

A list of prepared criteria, with some practical testing, allows the software evaluator to verify that the project objectives have been met. Table 5.1 is intended to collect feedback from end users of the mobile app and the system. It was distributed to users. Then evaluated the returned modules to obtain real customer feedback and to assess whether the project objectives were met. In the analysis, a measure against the Likert scale was used to measure the feedback. (McLeod, 2019)

Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
(1)	(2)	(3)	(4)	(5)

Table 5. 11 - Likert scale Options and Values

User evaluation of this project was focused on following subject areas,

- Appearance
- Usability
- Functionality
- Performance
- Security

Please refer Appendix A for the questionnaire

5.7 User Evaluation Results

All the results are collected from the google forms and evaluate under main categories. (Google, 2008)

5.7.1 User Evaluation Result for Appearance

Results for the four questions that asked under the appearance category ware summarized and Table 5.12 shows the final evaluation results. Then a graphical representation was developed (Figure 5.2) to present the result in more elegant way.

Likert scale	Individual Results				Total Result	In Percentage (%)
	Q1	Q2	Q3	Q4	T	
Strongly Disagree	0	0	0	0	0	0
Disagree	0	0	0	0	0	0
Neutral	0	0	3	0	3	4
Agree	7	7	7	11	32	45
Strongly Agree	11	11	8	7	37	51

Table 5. 12 - User Evaluation Result for Appearance

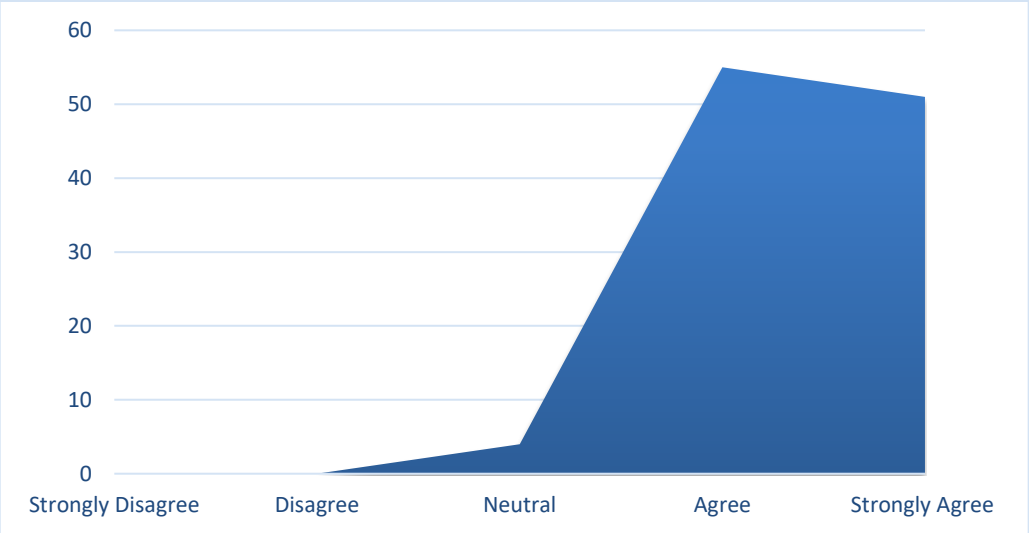


Figure 5. 2 - User Evaluation Result graphical representation for Appearance

As clearly represented in the graph almost all the users are in positive mind about the user interfaces of the proposed mobile app.

5.7.2 User Evaluation Result for Usability

Results for the four questions that asked under the usability category ware summarized and Table 5.13 shows the final evaluation results. Then a graphical representation was developed (Figure 5.3) to present the result in more elegant way.

Likert scale	Individual Results				Total Result	In Percentage (%)
	Q1	Q2	Q3	Q4	T	
Strongly Disagree	0	0	0	0	0	0
Disagree	0	0	0	0	0	0
Neutral	0	1	2	1	4	6
Agree	9	8	7	11	35	48
Strongly Agree	9	9	9	6	33	46

Table 5. 13 - User Evaluation Result for Usability

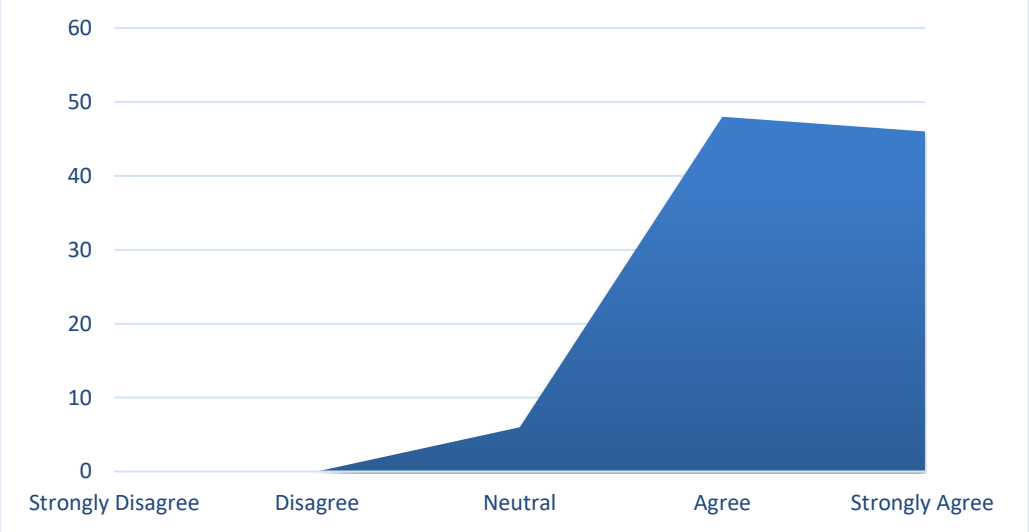


Figure 5. 3 - User Evaluation Result graphical representation for Usability

As clearly represented in the graph almost all the users are in positive feedback about the usability of the proposed mobile app.

5.7.3 User Evaluation Result for Functionality

Results for the four questions that asked under the Functionality category ware summarized and Table 5.14 shows the final evaluation results. Then a graphical representation was developed (Figure 5.4) to present the result in more elegant way.

Likert scale	Individual Results				Total Result	In Percentage (%)
	Q1	Q2	Q3	Q4	T	
Strongly Disagree	0	0	0	0	0	0
Disagree	0	0	0	0	0	0
Neutral	0	1	3	0	4	6
Agree	10	13	7	6	36	50
Strongly Agree	8	4	8	12	32	44

Table 5. 14 - User Evaluation Result for Functionality

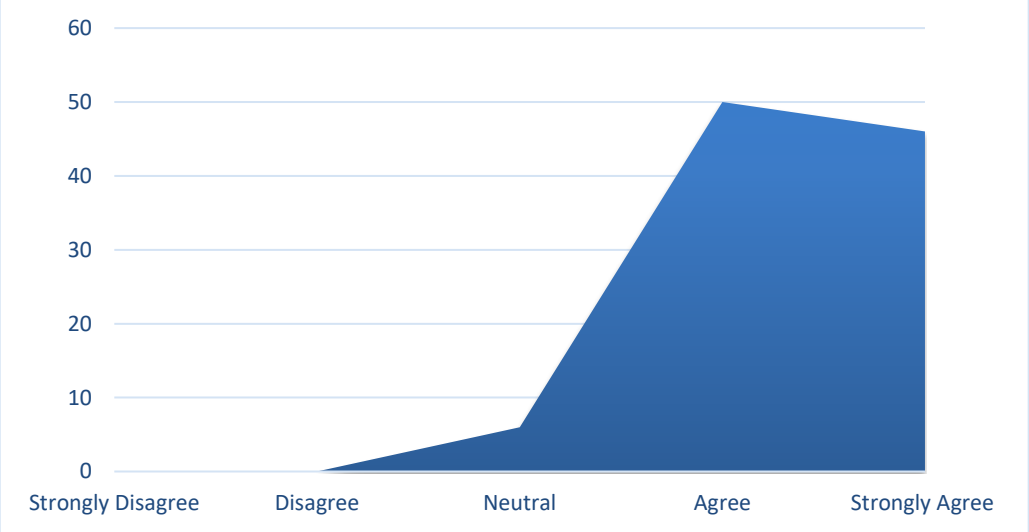


Figure 5. 4 - User Evaluation Result graphical representation for Functionality

As clearly represented in the graph almost all the users believe that this mobile app can provide all the functionalities that are required.

5.7.4 User Evaluation Result for Performance

Results for the four questions that asked under the Performance category ware summarized and Table 5.15 shows the final evaluation results. Then a graphical representation was developed (Figure 5.5) to present the result in more elegant way.

Likert scale	Individual Results				Total Result	In Percentage (%)
	Q1	Q2	Q3	Q4	T	
Strongly Disagree	0	0	0	0	0	0
Disagree	0	0	0	0	0	0
Neutral	2	0	2	0	4	6
Agree	6	13	5	14	38	53
Strongly Agree	10	5	11	4	30	41

Table 5. 15 - User Evaluation Result for Performance

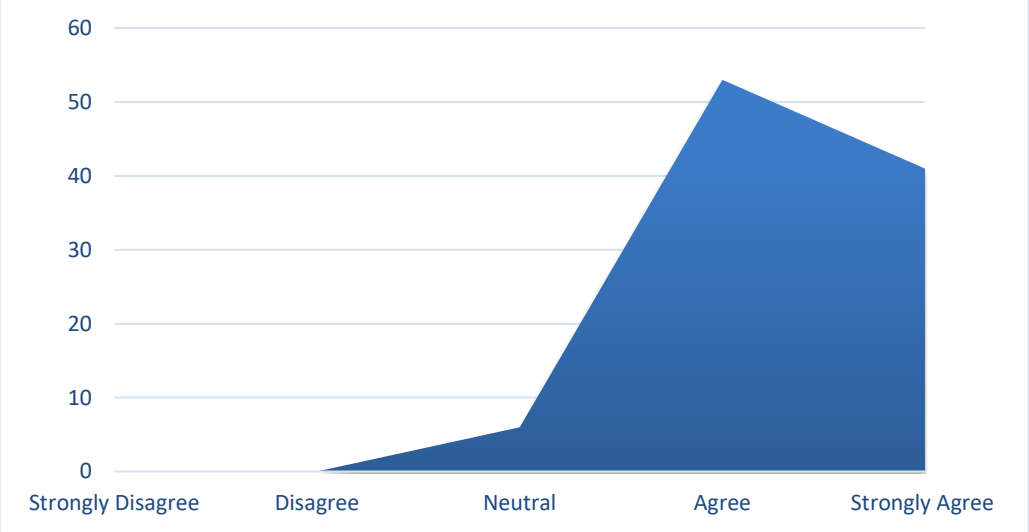


Figure 5. 5 - User Evaluation Result graphical representation for Performance

As clearly represented in the graph almost all the accept that the performances of this proposed app are satisfactory.

5.7.5 User Evaluation Result for Security

Results for the four questions that asked under the Security category ware summarized and Table 5.16 shows the final evaluation results. Then a graphical representation was developed (Figure 5.6) to present the result in more elegant way.

Likert scale	Individual Results				Total Result	In Percentage (%)
	Q1	Q2	Q3	Q4	T	
Strongly Disagree	0	0	0	0	0	0
Disagree	0	0	0	0	0	0
Neutral	0	0	0	0	0	0
Agree	7	7	11	8	33	46
Strongly Agree	11	11	7	10	39	54

Table 5. 16 - User Evaluation Result for Security

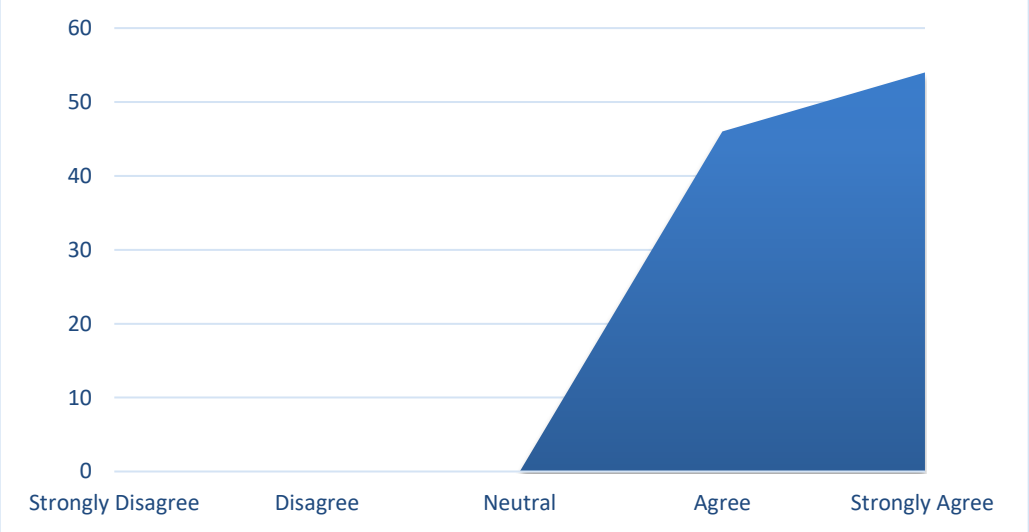


Figure 5. 6 - User Evaluation Result graphical representation for Security

As clearly represented in the graph almost all the accept that the performances of this proposed app are satisfactory.

5.7.6 User Evaluation Result Summary

Results for all the categories ware summarized and Table 5.17 shows the final evaluation summary results. Then a graphical representation was developed (Figure 5.7) to present the result in more elegant way.

Likert scale	Appearance	Usability	Functionality	Performance	Security	Total	In Percentage (%)
Strongly Disagree	0	0	0	0	0	0	0
Disagree	0	0	0	0	0	0	0
Neutral	3	4	4	4	0	15	4.5
Agree	32	35	36	38	33	174	48
Strongly Agree	37	33	32	30	39	171	47.5

Table 5. 17 -User Evaluation Result for Summary

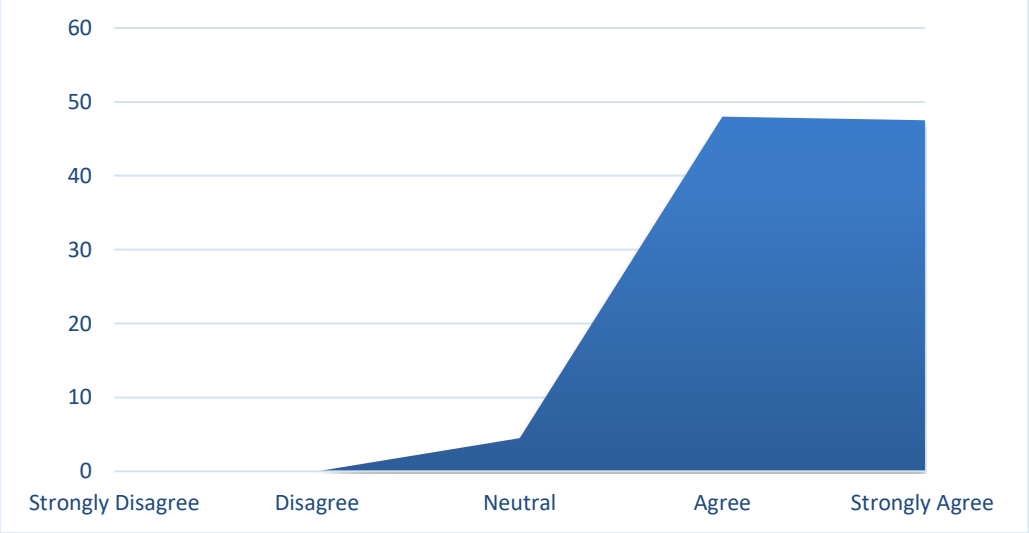


Figure 5. 7 -User Evaluation Result graphical representation for Summary

As clearly represented in the graph 95.5% of the users in this proposed application are accept the system with Agree or Strongly Agree status. Only the 4.5% of the users are in Neutral situation.

Please refer Appendix B for the google form results

Chapter 6: Conclusion

6.1 Introduction

In Conclusion phase, that main objective to explain that how well the proposed system solves the problem that defined in Introduction chapter. And also, how much this solution affected to the relevant bodies in relevant fields. This chapter also describe the Problems encounter, lesson learned and future works to be done relevant to the project.

6.2 Critical Evaluation

With the proposed system NWSDB was able to achieve the followings

1. Reduce the time that the meter reader complaint transfers to the field service team from two weeks to maximum of 30 minutes.
2. Implement 100% paperless meter reader complaint management process
3. Make the meter reader complaint management process 100% transparent and 99% accurate.
4. Implement real time reconciliation of Inventory and Labor force.
5. 96% Agree and Strongly Agree feedback from users for the Appearances.
6. 94% Agree and Strongly Agree feedback from users for the Usability.
7. 94% Agree and Strongly Agree feedback from users for the Functionality.
8. 94% Agree and Strongly Agree feedback from users for the Performances.
9. 100% Agree and Strongly Agree feedback from users for the Security.

Ultimately the Proposed system become an enormous advantage to achieve the Vision of the NWSDB which is “To be the most prestigious utility organization in Sri Lanka through technology and Service excellence”.

6.3 Problems Encountered

The following problems were encountered during system development, implementation and maintenance process,

- Office procedure related problems when converting from fill paper method to paperless method.
- Employees who involving in the older paper-based process misunderstand that this project will critically affect to their jobs.

- Workers who misuse the Inventory show their unlikeness to the system when the project make the Inventory management 100% transparent.
- Labors who are not attend to their jobs in full office times do not like to being monitored.
- The user needs to be online with the system to use the Meter Reader Complaint Management App.
- Thermal printed bill does not have longer lifetime and can affect with heat and the chemicals such as hand sanitizers.
- Less number of senior employees who are embedded to their usual procedures do not like to try new technologies and methods.
- Capturing GPS location without the GPS capturing device is not accurate.
- Most of the GPS locations and correct contact numbers are not available in the system.

6.4 Lesson learned

Following lessons are learned in the process of development, implementation and maintenance of the proposed system,

- It is better to parameterized all the critical details weather they are fixed or not, it will help in maintenance phase,
- It is necessary to consider max font size that mobile OS provide when designing the screens.
- It is vice method to consider the accuracy level when capturing the GPS locations.
- Many brainstorming sessions needed to be conduct o change the mindset of the employees in some environments to implement new technologies
- Digital signature in not yet recognized as valid from the default sources such as android device.
- When considering islanded we cannot rely on only online method for this solution.

6.5 Future Enhancements

This system is designed according to customer requirements. Here are some extensions that can be added to the system in the future.

- Add GIS maps to show the pipeline layout of the selected area to increases the accuracy of the digging activities.
- Use special paper that can be used in thermal printed that has longer lifetime.
- Introduce e-receipt to send via emails and WhatsApp instead off printed receipt.

- Add a facility to connect with the original GPS capturing device nearby and transfer the accurate GPS location to Meter Reader Complaint Management App.
- Introduce payment method incorporated with cared reader device.
- Include Digital signature facility into the mobile application
- Provide Printed receipt tot the customer after the job done

References

Anon., 2019. *Reference & Research Skills.* [Online]
Available at: https://pitt.libguides.com/citationhelp
[Accessed 3 February 2021].

Clouder, A., 2020. *How to Create an Effective Technical Architectural Diagram.* [Online]
Available at: https://www.alibabacloud.com/blog/how-to-create-an-effective-technical-architectural-diagram_596100
[Accessed 10 March 2021].

Google, 2008. *Google Forms.* [Online]
Available at: https://www.google.com/forms/about/
[Accessed 5 6 2021].

guru99, 2021. *What is Software Testing? Definition, Basics & Types.* [Online]
Available at: https://www.guru99.com/software-testing-introduction-importance.html

hmookna, 2018. *The post office project.* [Online]
Available at: https://sites.google.com/site/hmookna/use-case-narrative
[Accessed 9 March 2021].

IFS, 1995. *Mobile Field Service Solutions.* [Online]
Available at: https://www.ifs.com/solutions/service-management/mobile-field-service/
[Accessed 26 February 2021].

kaushal, k., 2020. *Android React Native Window Setup.* [Online]
Available at: https://levelup.gitconnected.com/android-react-native-window-setup-how-to-setup-android-environment-for-react-native-app-588aaa13c3a6
[Accessed 25 May 2021].

Kissflow, 2021. *Rapid Application Development (RAD).* [Online]
Available at: https://kissflow.com/low-code/rad/rapid-application-development/
[Accessed 4 February 2021].

LaneSquare, 2020. *Field Service Management (FSM) App.* [Online]
Available at: https://apkpure.com/field-service-management-fsm-app/kc.care.task
[Accessed 12 9 2021].

McLeod, D. S., 2019. *Likert Scale Definition, Examples and Analysis.* [Online]
Available at: https://www.simplypsychology.org/likert-scale.html
[Accessed 28 6 2021].

Milk, F., 2019. *Field Service Software in Sri Lanka | Flobot"..* [Online]
Available at: https://www.freshmilksoftware.com/flobot/field-service-job-management-software-sri-lanka.html
[Accessed 26 February 2021].

NWSDB, 2012. *Key Information.* [Online]
Available at:
http://www.waterboard.lk/web/index.php?option=com_content&view=article&id=76&Itemid=103&lang=en
[Accessed 2 February 2021].

paradigm, V., 2020. *UML Class Diagram Tutorial.* [Online]
Available at: https://www.visual-paradigm.com/guide/uml-unified-modeling-language/uml-class-diagram-tutorial/
[Accessed 10 March 2021].

project, T. p. o., 2018. *Use case narrative.* [Online]
Available at: https://sites.google.com/site/hmookna/use-case-narrative
[Accessed 9 March 2021].

Rajkumar, 2020. *How to Write Test Cases.* [Online]
Available at: https://www.softwaretestingmaterial.com/test-case-template-with-explanation/
[Accessed 20 06 2021].

Rajkumar, 2021. *Maintenance Testing Guide.* [Online]
Available at: https://www.softwaretestingmaterial.com/maintenance-testing/
[Accessed 18 6 2021].

Wikipedia, 2020. *Model–view–controller.* [Online]
Available at: https://en.wikipedia.org/wiki/Model%E2%80%93view%E2%80%93controller
[Accessed 4 February 2021].

wilda, 2014. *All You Need to Know About UML Diagrams.* [Online]
Available at: https://tallyfy.com/uml-diagram/
[Accessed 8 March 2021].

www.softwaretestinghelp.com, 2020. *A Complete Non-Functional Testing Guide.* [Online]
Available at: https://www.softwaretestinghelp.com/what-is-non-functional-testing/
[Accessed 26 06 2021].

Appendix A – System Manual

1. Metering System

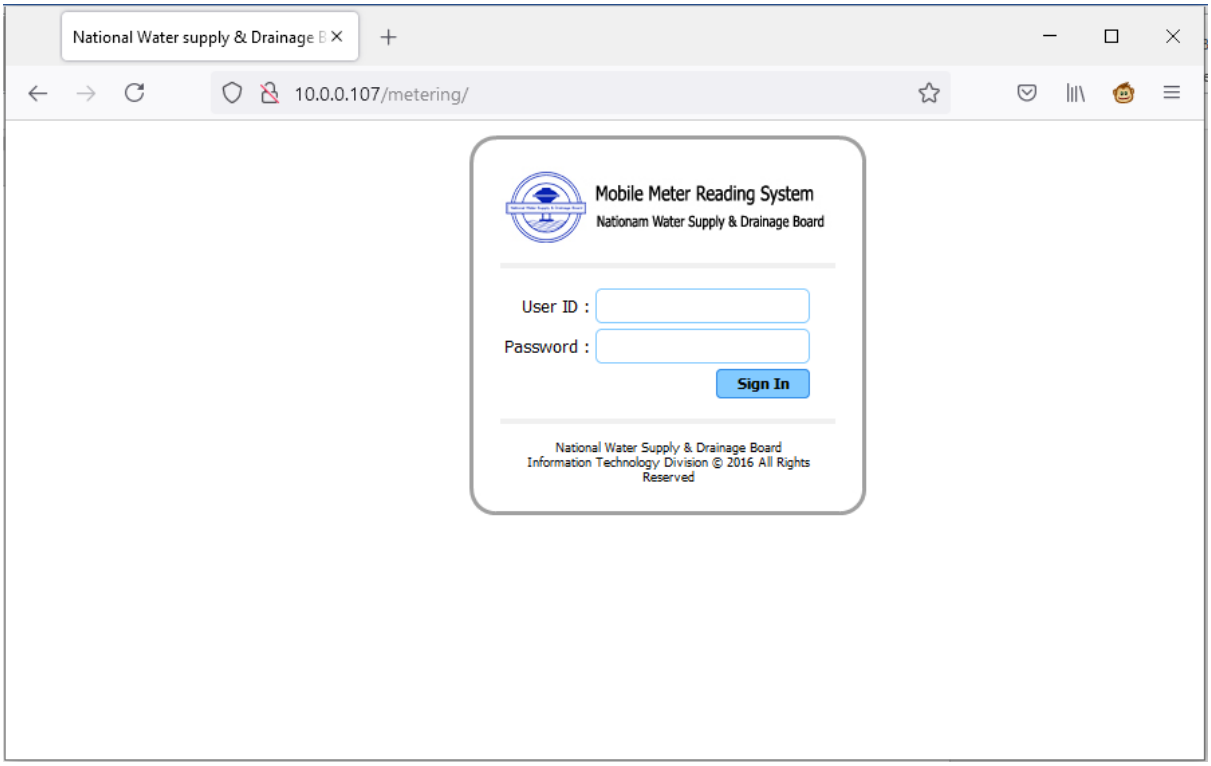
Recommended bowsers

Chrome Firefox Edge Safari

URLs

Through VPN - 10.0.0.107/metering

Through Internet - bis.waterboard.lk/metering

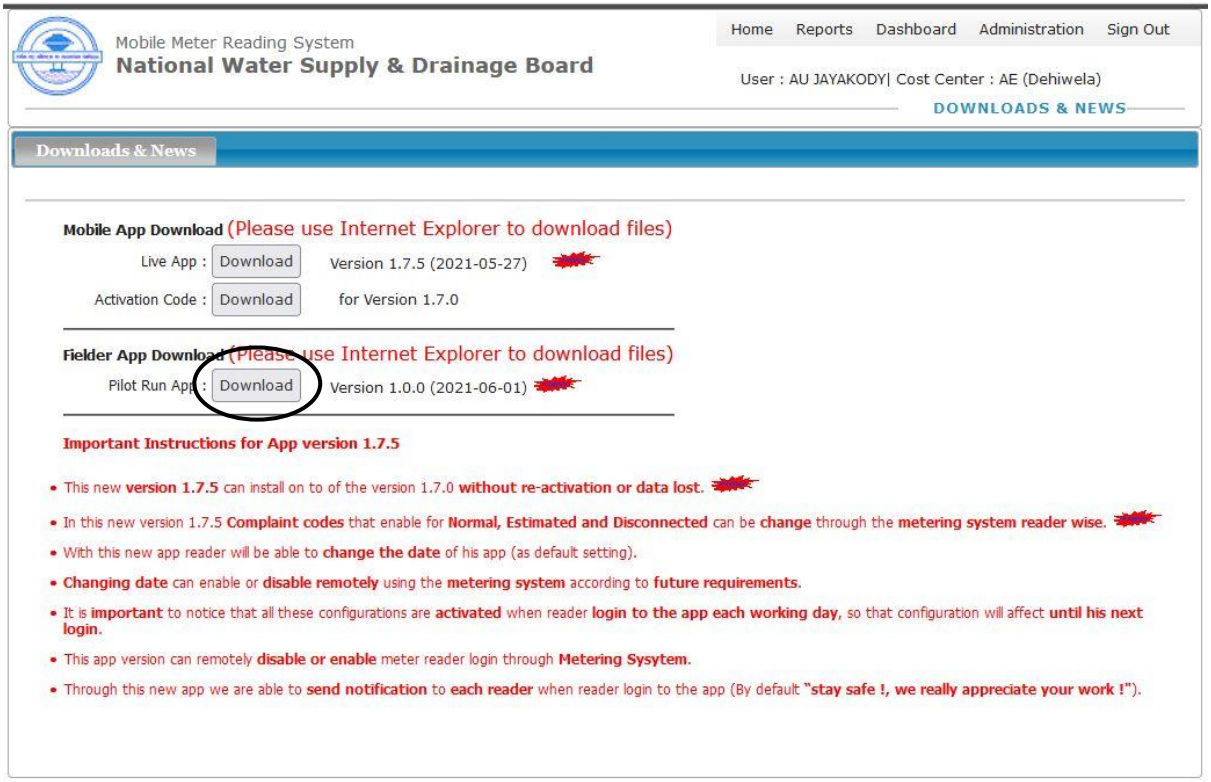


2. Meter Reader Complaint Management Mobile App

Step 1 - Download the available App version from the Metering System.

Go to – **Administrator** > **Downloads & News**

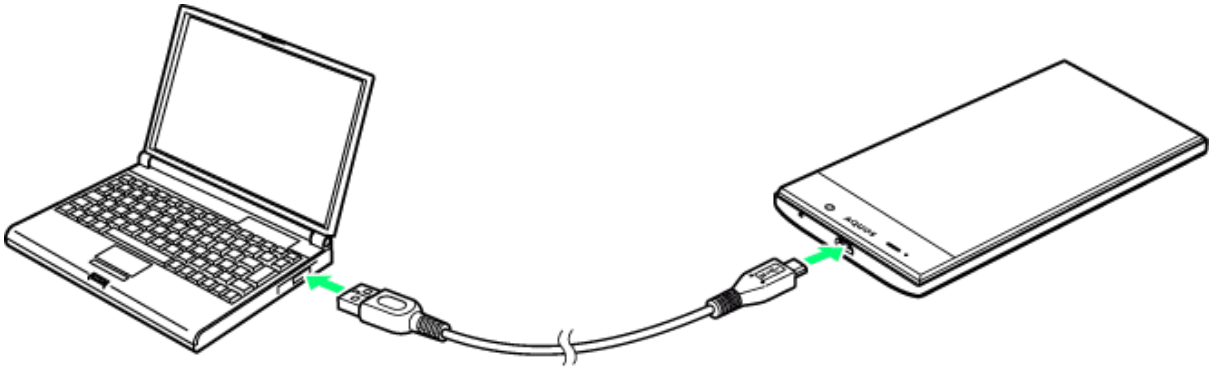
Click Download button to download the available version of the Fielder App.



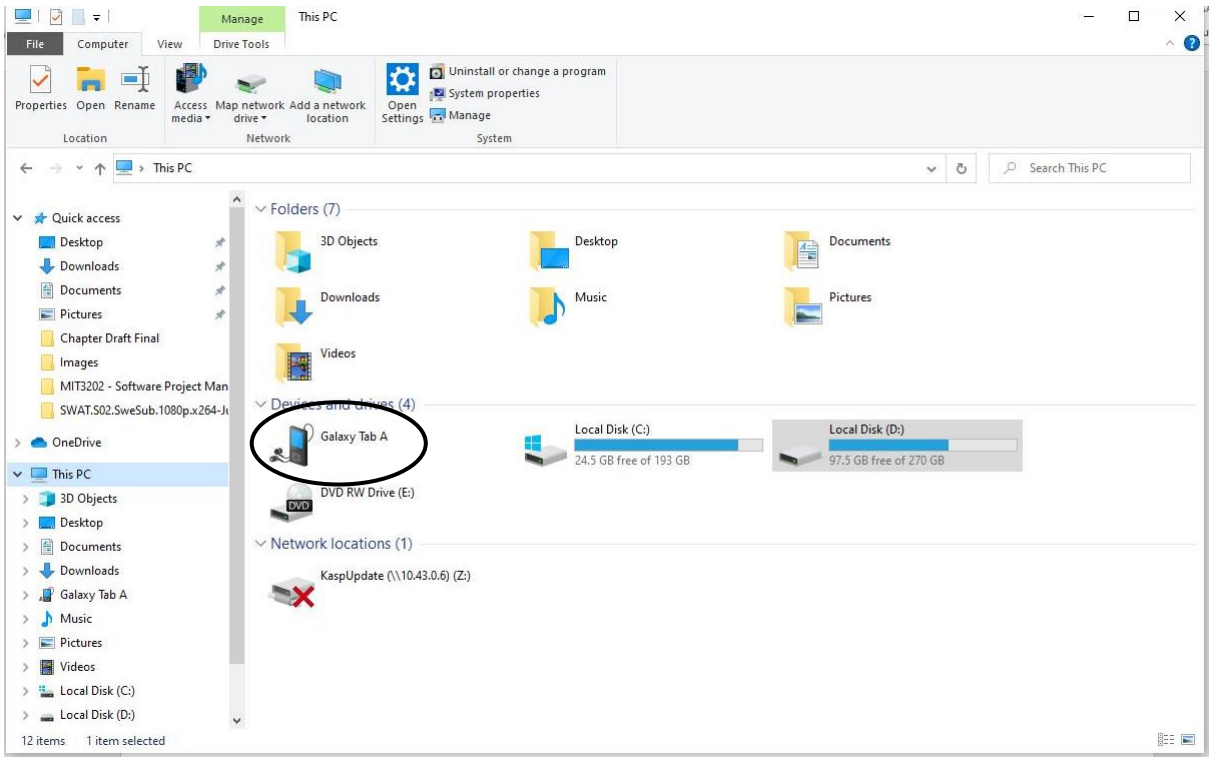
Save the .apk file onto your PC

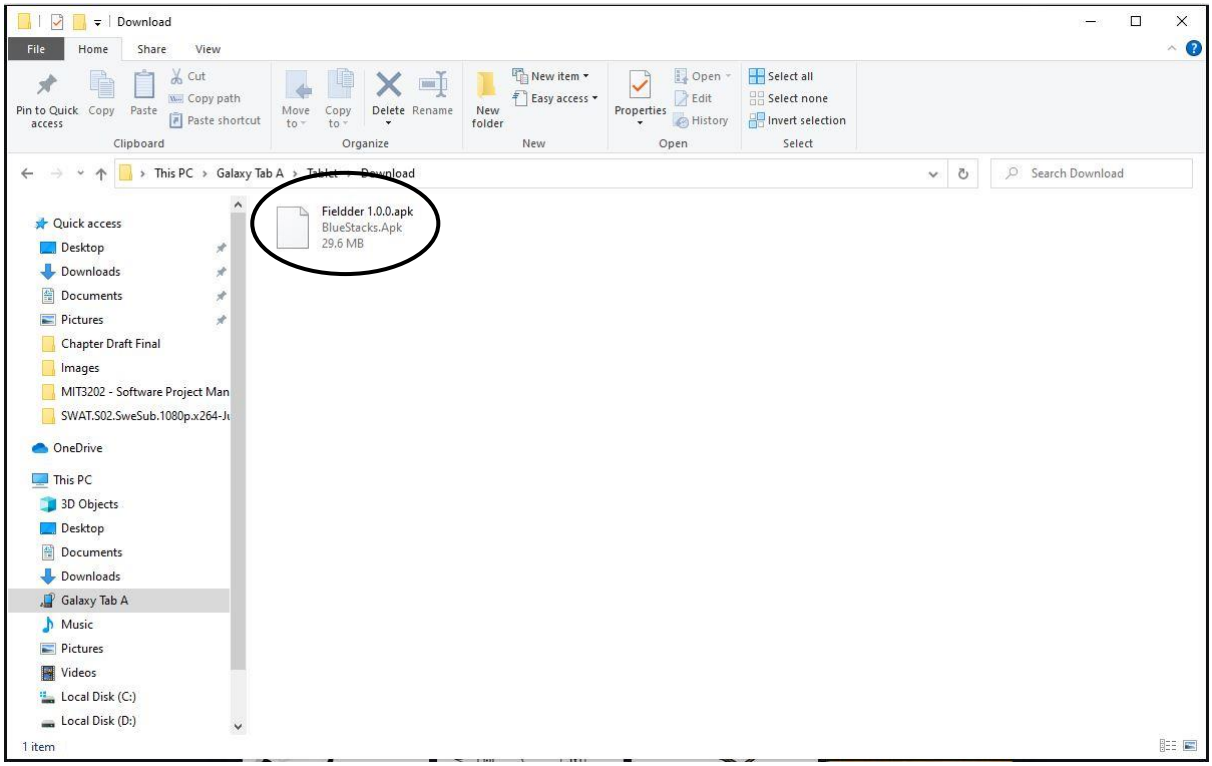
Step 2 - Transfer .apk file to mobile device

Connect the mobile device to your pc using USB cable

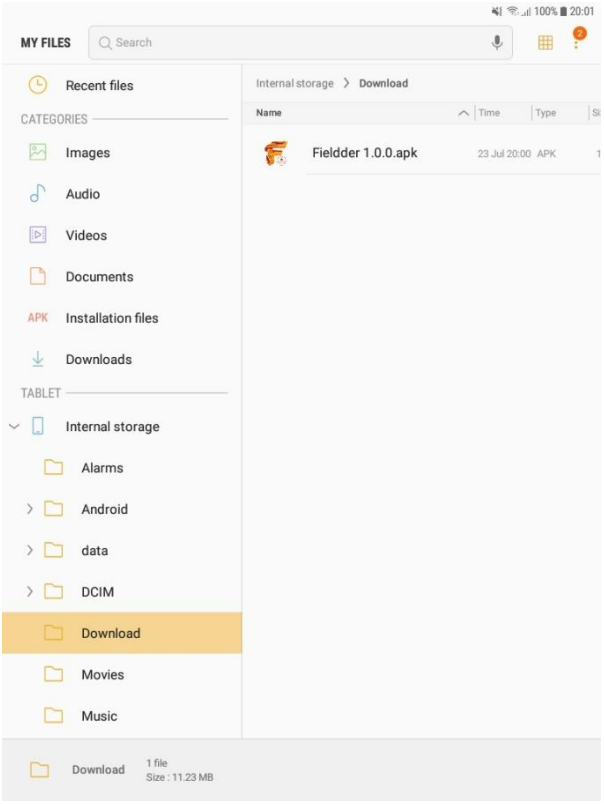


Open the mobile device storage and transfer the .apk file to the device

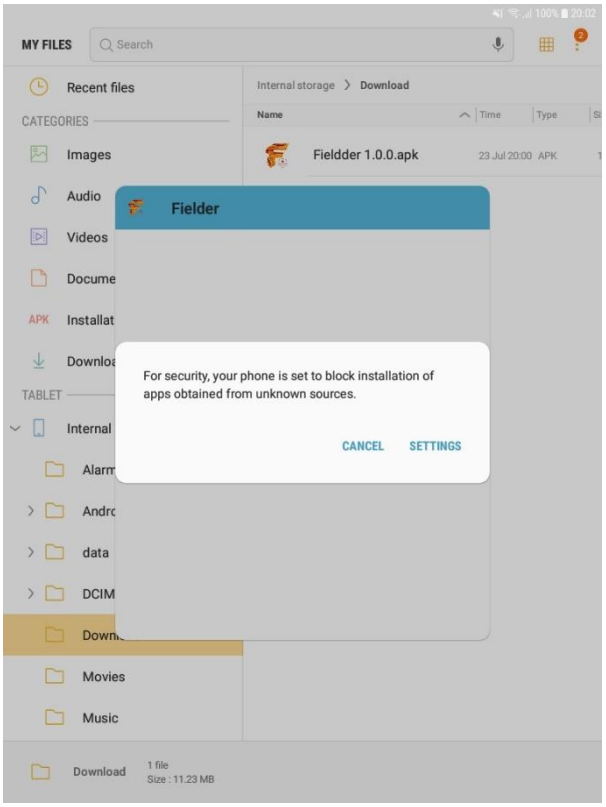




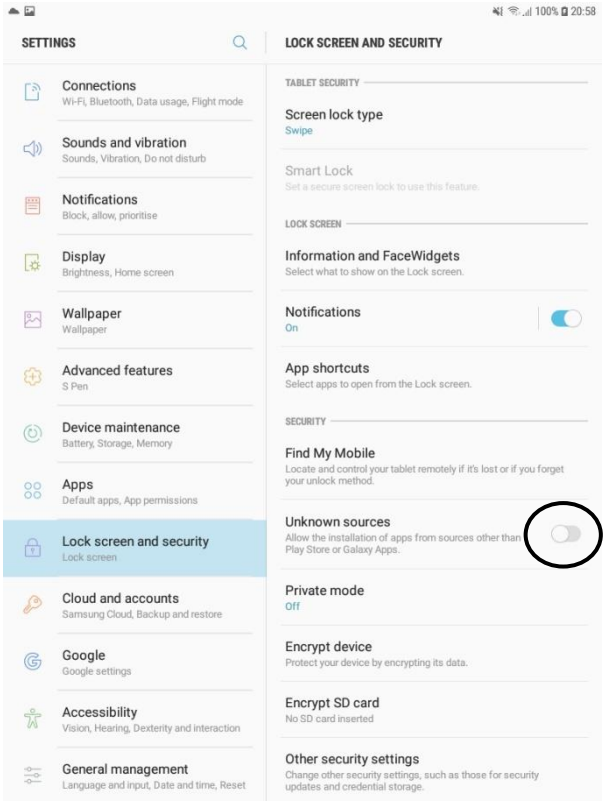
Step 3 – Install the app



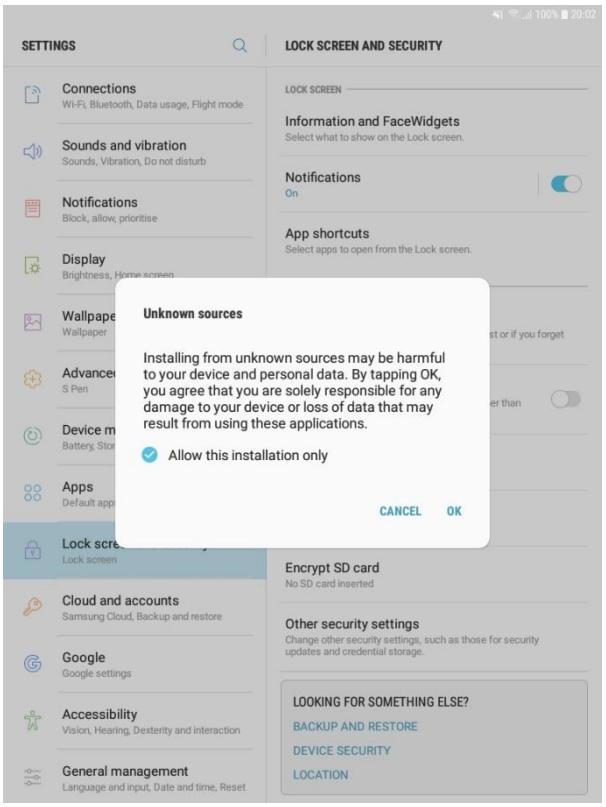
locate* the Fielder App *and select



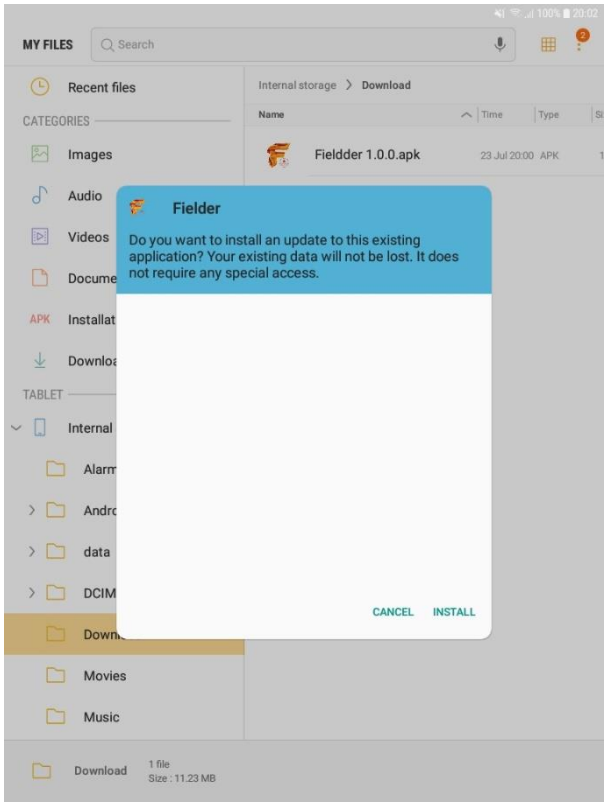
Click Settings *in popup*



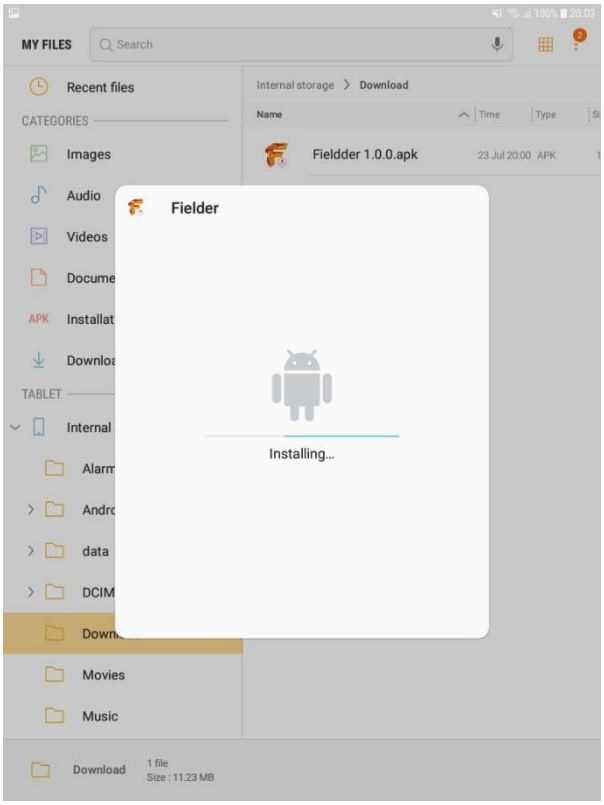
Enable Unknown sources option



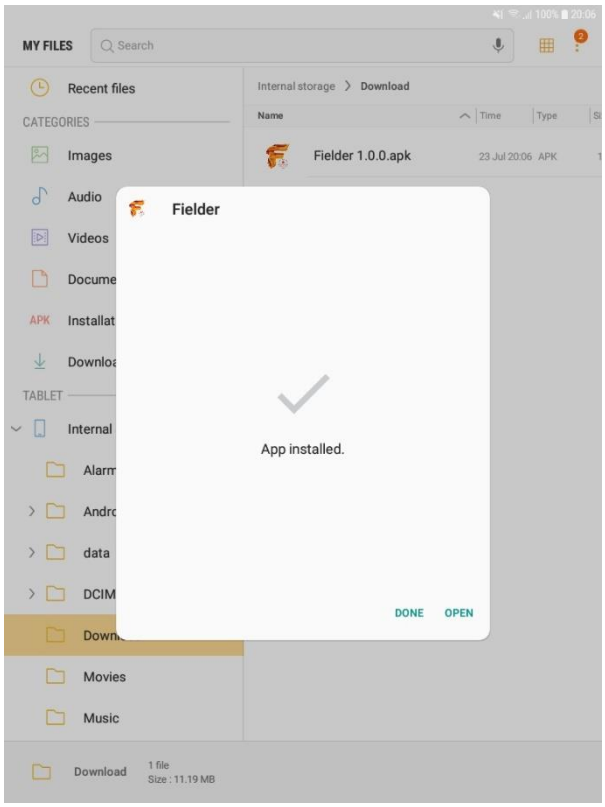
Click Ok



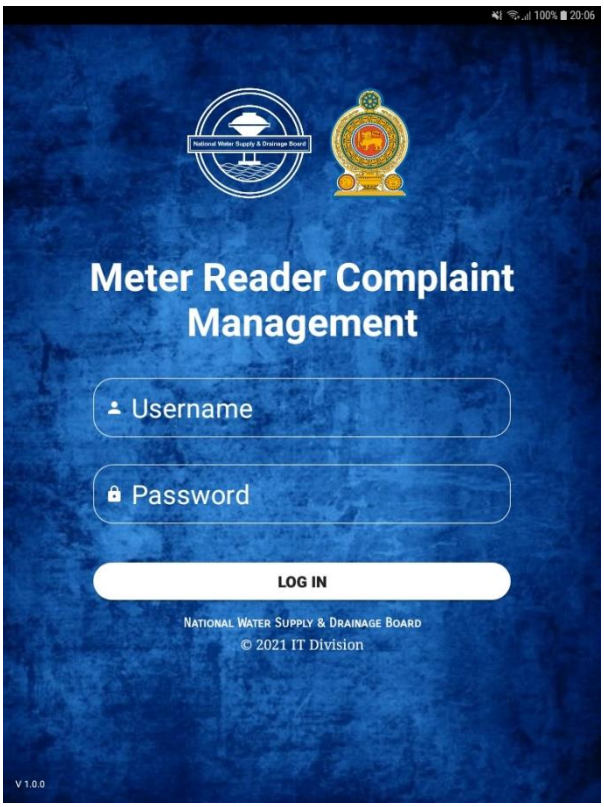
Click Install



Let the application install



Click Open



Login Screen

Appendix B - User Manual

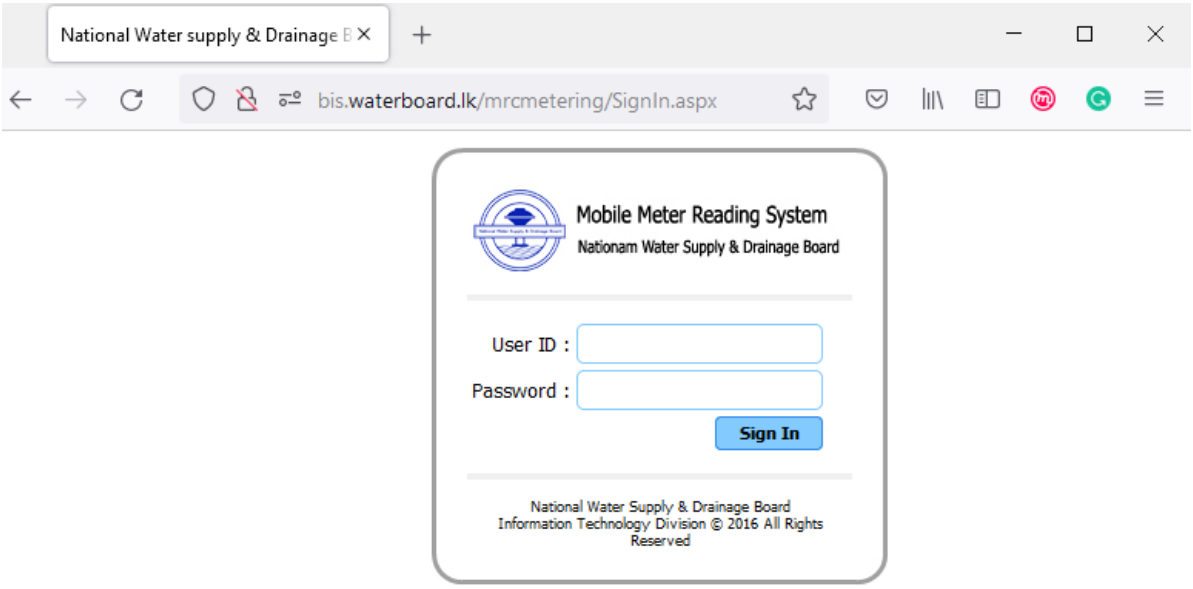
Metering System

1. Login to the system

URLs

Through VPN - **10.0.0.107/mrcmetering**

Through Internet - **bis.waterboard.lk/mrcmetering**



B. 1 - Metering System Login Interface

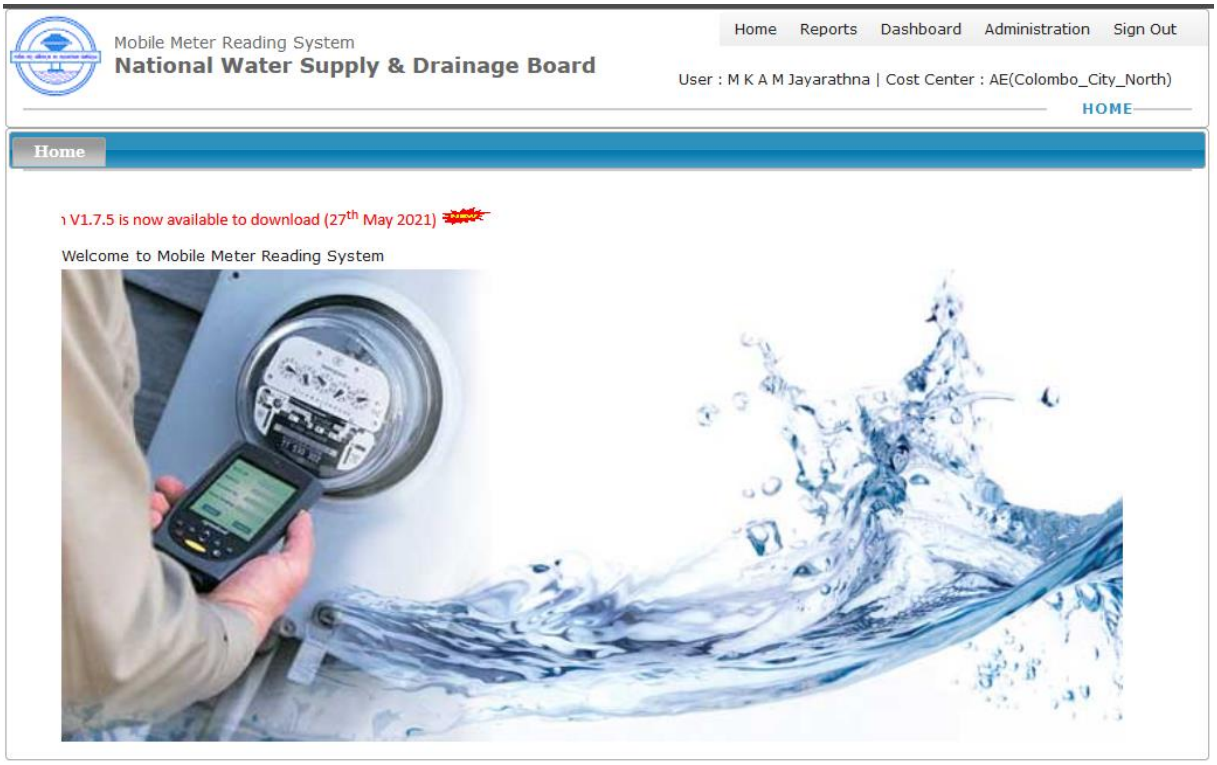
Figure B.1 is the login screen of the metering system.

Receiving Username and the password can be only done through the written request to the relevant System Administrator of your region.

You should be the employee and should have valid Employee number to apply for the login.

Default username and password will be your Employee Number and you can reset your password through the metering system.

In case you cannot login to the system because of forgetting password after you change you can request system administrator to reset your password back to default.



B. 2 - Home Interface

Figure B.2 is the Home Interface.

Home interface has header area which is constant throughout the whole solution. It has key menu categories of the solution as **Reports, Dashboard and Administration** along with **Home** and **Logout** menu options.

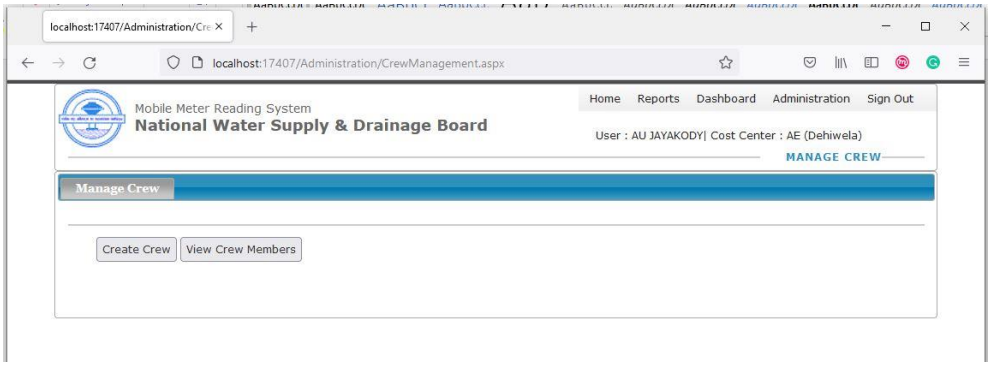
Header also includes Your name and yours relevant cost center name. please make sure those information's are correct before continue using the solution.

Home interface includes welcome screen and you can see the red color moving notification bar that shows the latest modification and app releases relevant to the system.

All the relevant interfaces that you can use are based on the sub menu items in the header section.

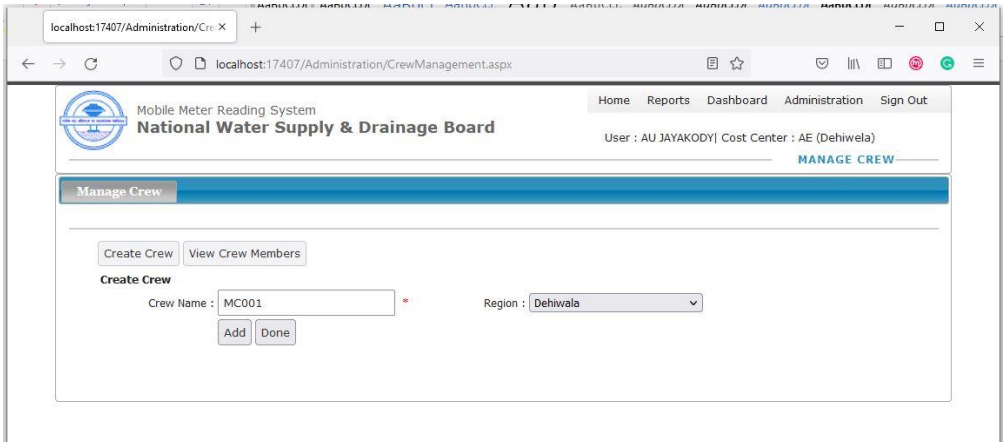
2. Manage Crew

Menu Navigation - **Administrator** > **Crew Management**



B. 3 - Manage crew Interface

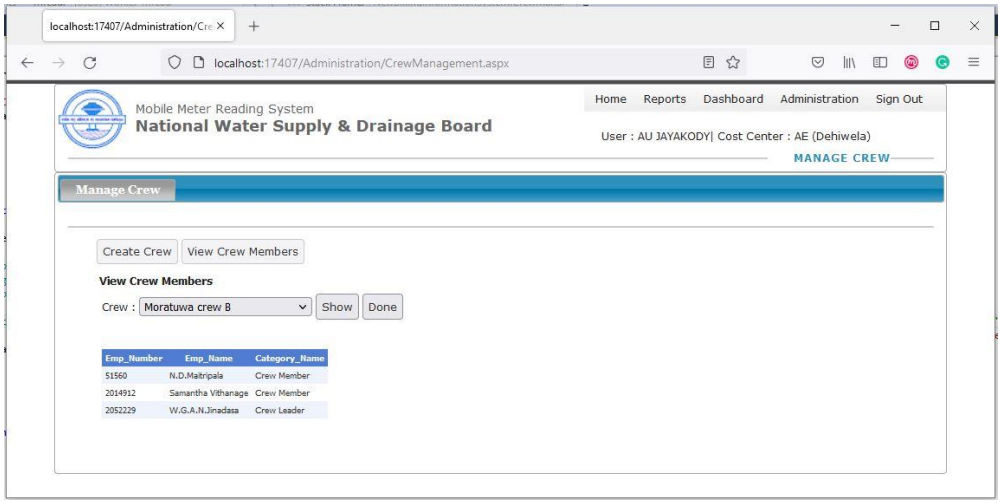
Here Figure B.3 show the Manage crew Interface which you can go through the given menu navigation instructions.



B. 4 - Create crew interface

When you select “Create Crew” option in Manage Crew you can add new crew. You have to give the crew name and select the region. Then click “Add”. You are not allowed to delete or modify crew details after adding it.

View Crew Members

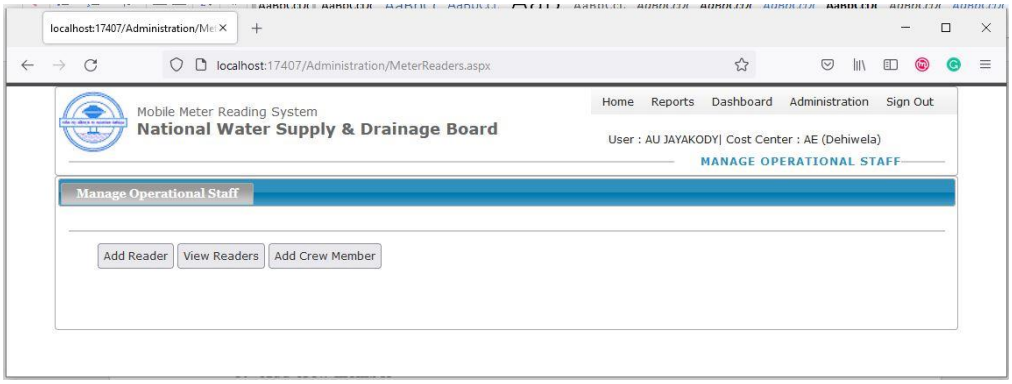


B. 5 - View crew interface

Figure B.5 show the interface for the "View Crew Members" option. Here you have to select the crew and press "Show" button.

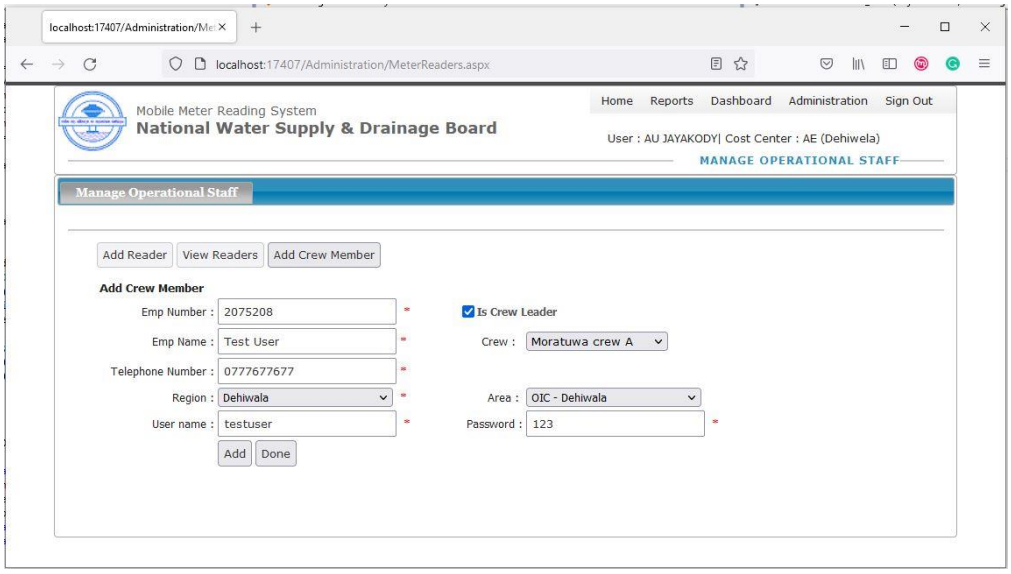
3. Add crew member

Menu Navigation - **Administrator** > **Operational Staff**



B. 6 - Manage Operational Staff Interface

Figure B.6 show the Manage Operational Staff Interface which you can go through the given menu navigation instructions. Here you can Add crew members to the relevant Crew.

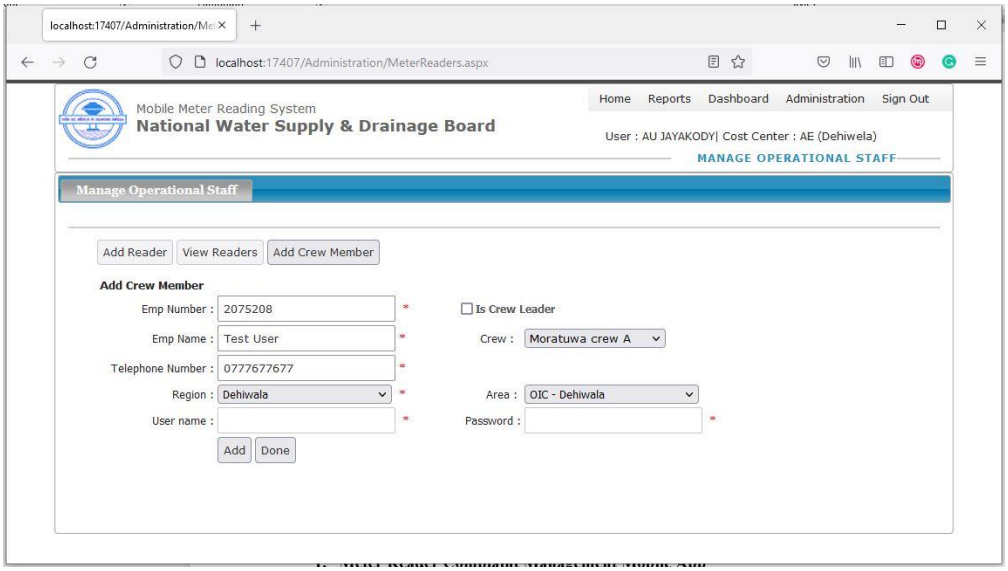


B. 7 - Add Crew Member Interface (Crew Leader)

Figure B.7 show the Add Crew Member option Interface. Here mandatary fields are indicated with * mark.

Crew member usually a board employee. If not, you can use his/her NIC number without letters instead of Employee number.

If you check the “Is Crew Leader” check box. Additional two text boxes, “Username” and “Password” will enable. Those are the credentials that crew leader use to login to the Meter Reader Complaint Management Mobile App.

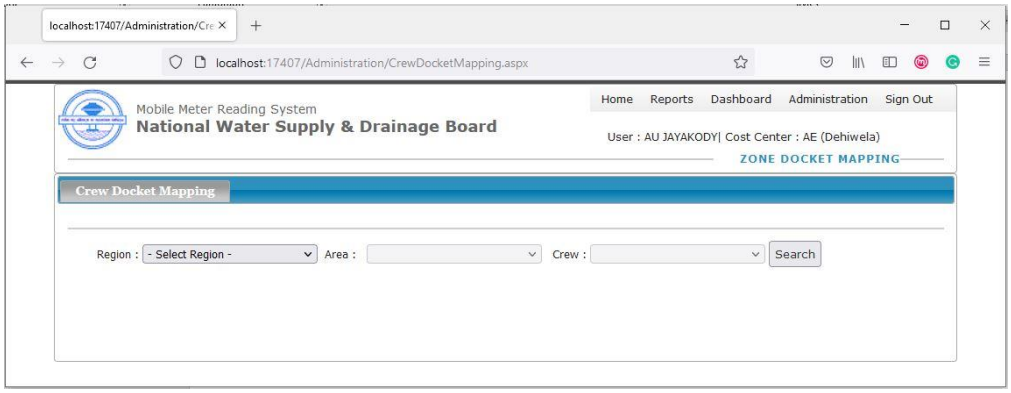


B. 8 - Add Crew Member Interface (Crew Member)

If you are going to add just a crew member you have to do the same as before instead of Username and Password.

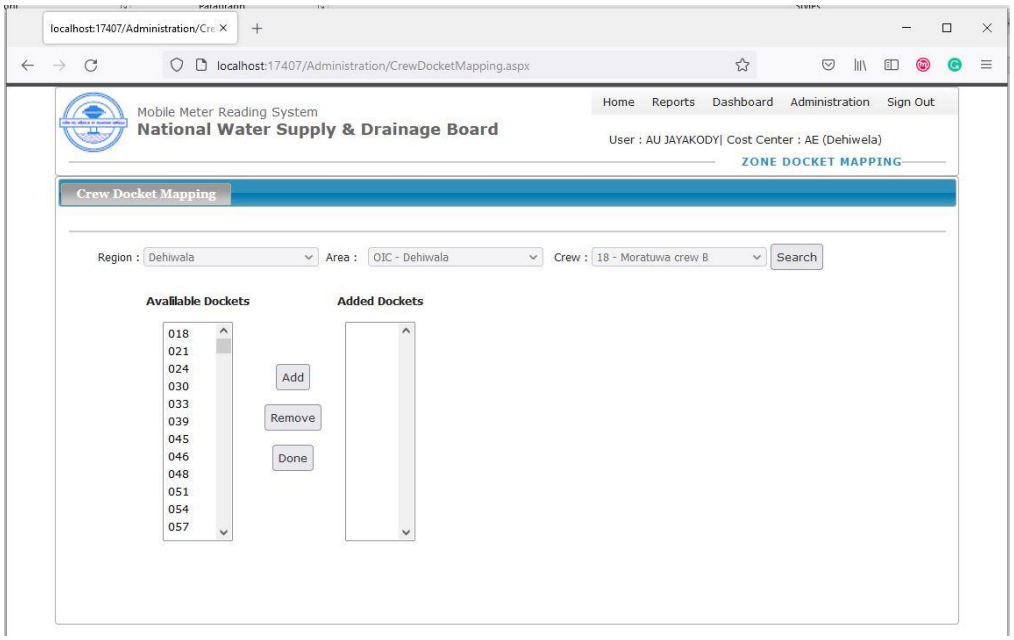
4. Crew Docket mapping

Menu Navigation - Administrator > Crew Docket Mapping



B. 9 - Crew Docket Mapping

Figure B.9 is the Crew Docket Mapping Interface. Here you can define which Crew have the responsibility of which Docket under each Region and Area. To enable mapping you must select Region, Area Under selected region and the Crew that you are going to map dockets. Then you can click “Search” button.



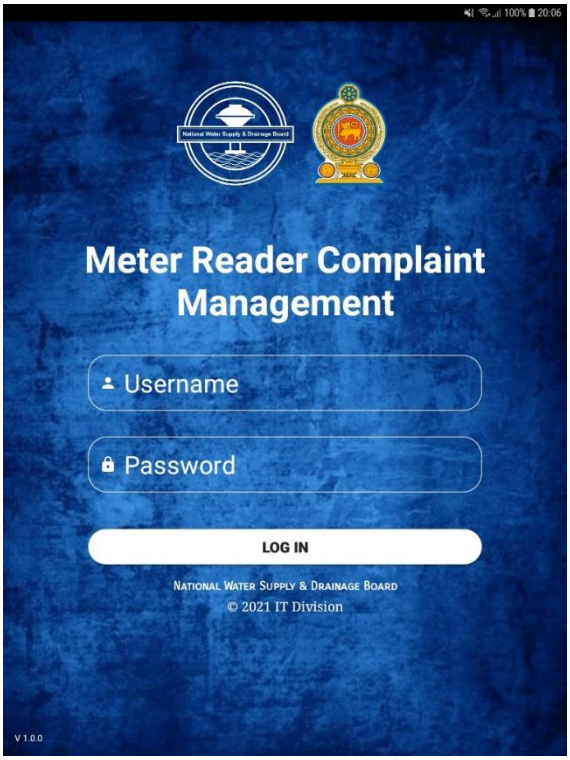
B. 10 - Add or Remove Mapping Interface

After click the “Search” button you can see this interface. Hear it shows already mapped docket in right hand side “Added Docket” box and Un mapped dockets in left hand side “Available Docket” box.

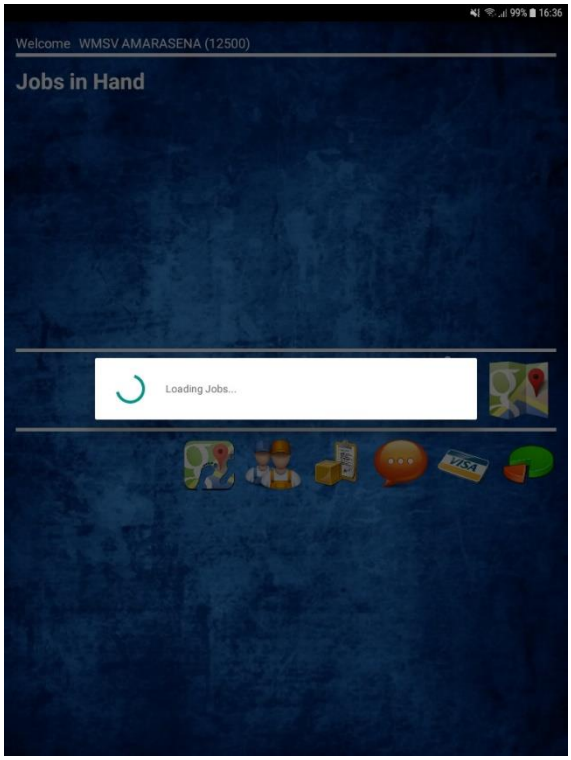
You can select docket from left-hand side and add to the right-hand side using “Add” button or select docket from right-hand side and add to left-hand side using “Remove” button.

Meter Reader Complaint Management App

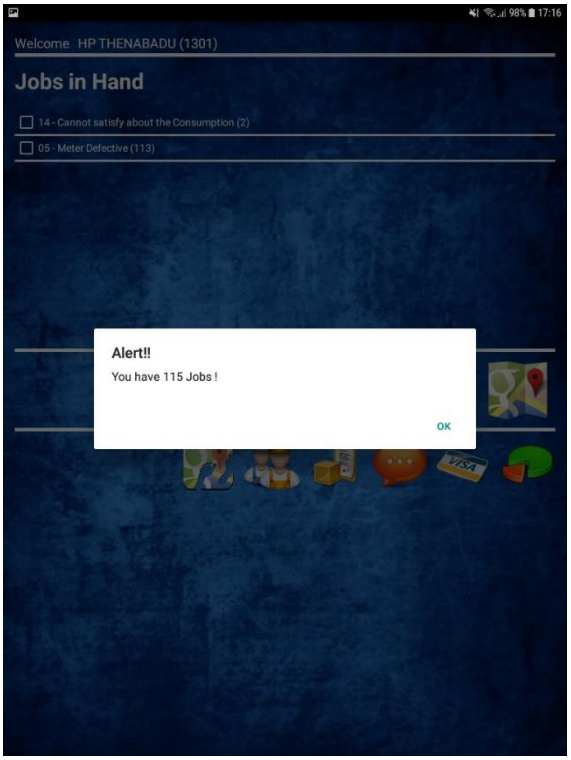
Clock on Fielder App icon to start the process



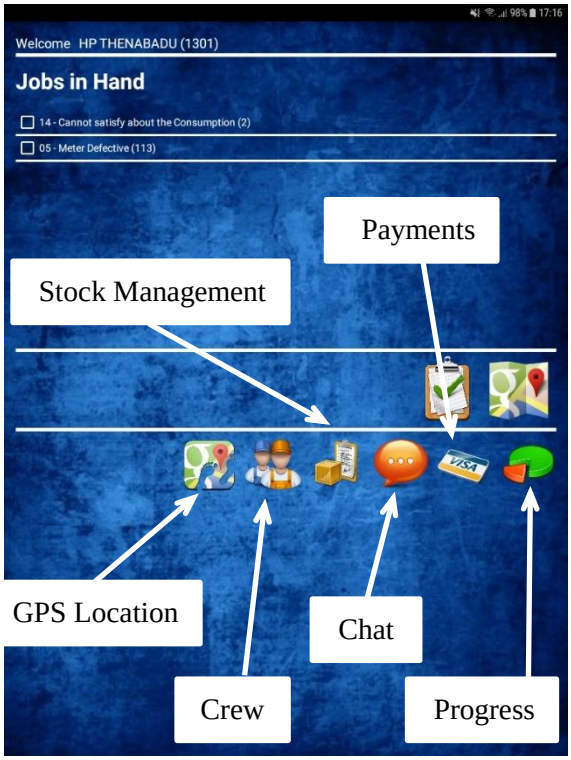
Here is the login screen and use provided credentials and press “Login” button to login to the app



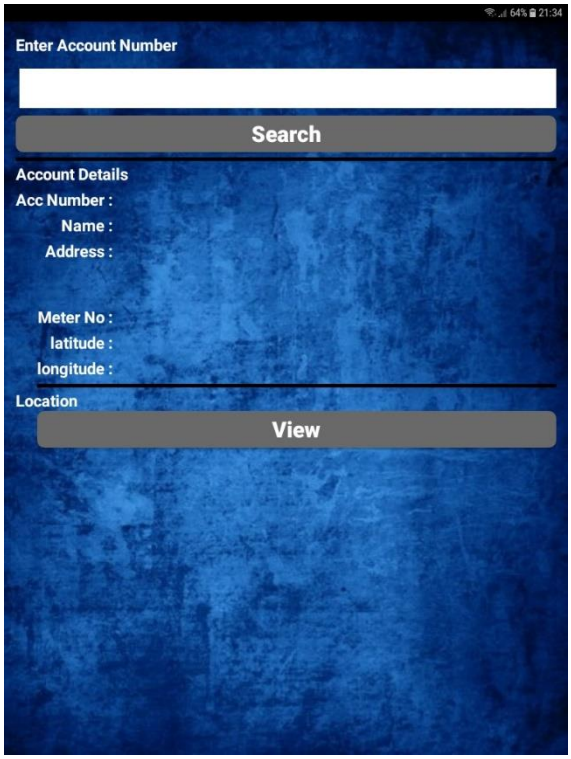
App will load all the relevant data in the beginning. **Do not touch the screen while data is loading**



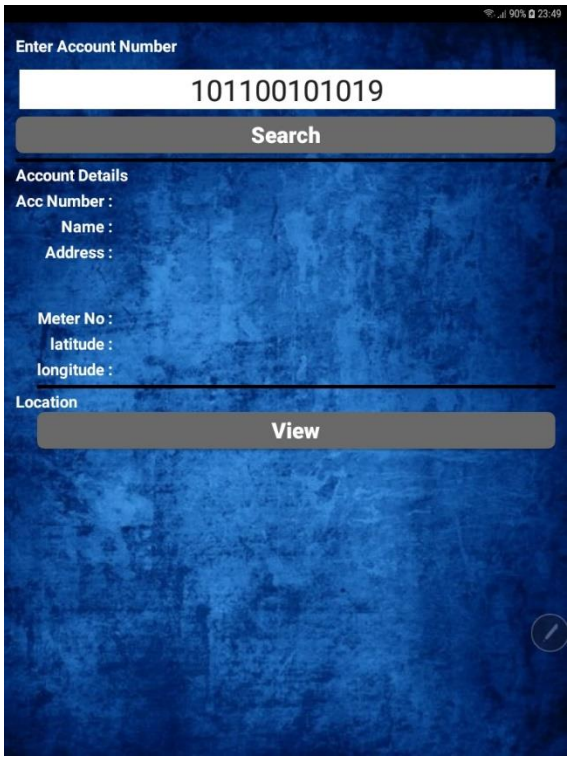
After loading all the relevant information’s the app will show nichification that show the count of all available pending jobs. Press “Ok”



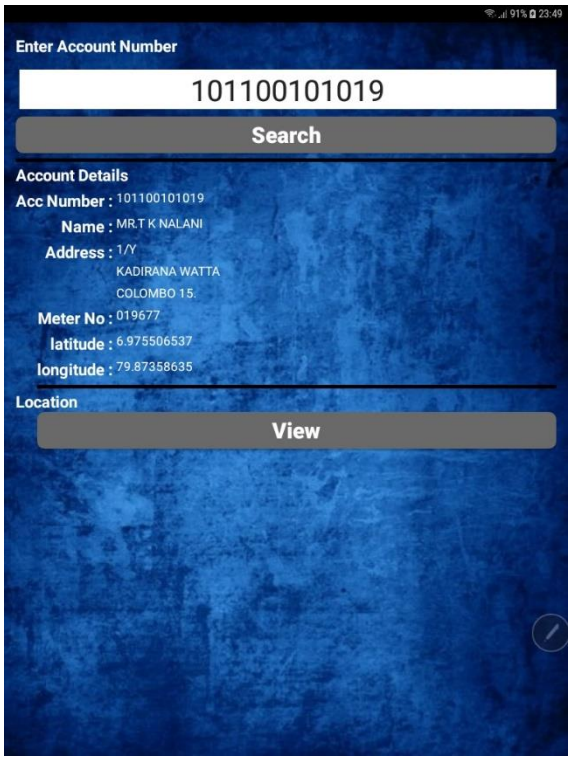
This is the Home screen and you can see all the icons with their definitions



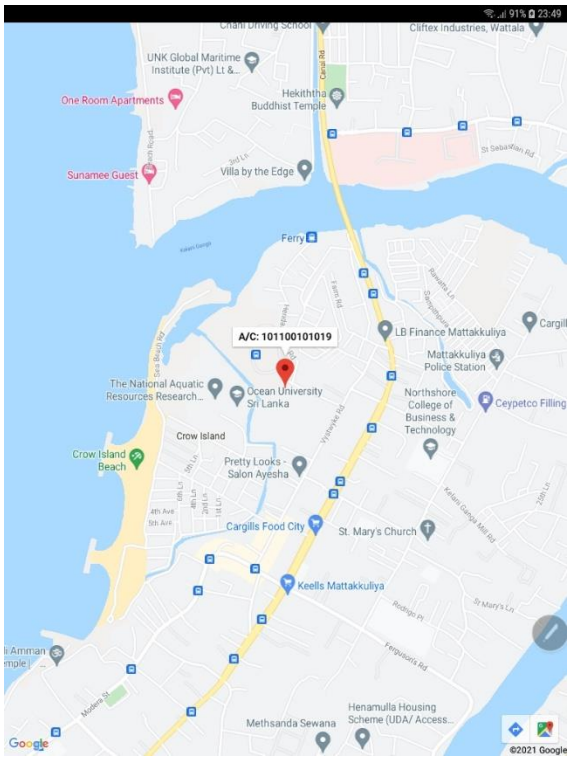
When you click on “GPS Location” icon app will direct you to this interface



You can enter the account number in given space and press “Search” button

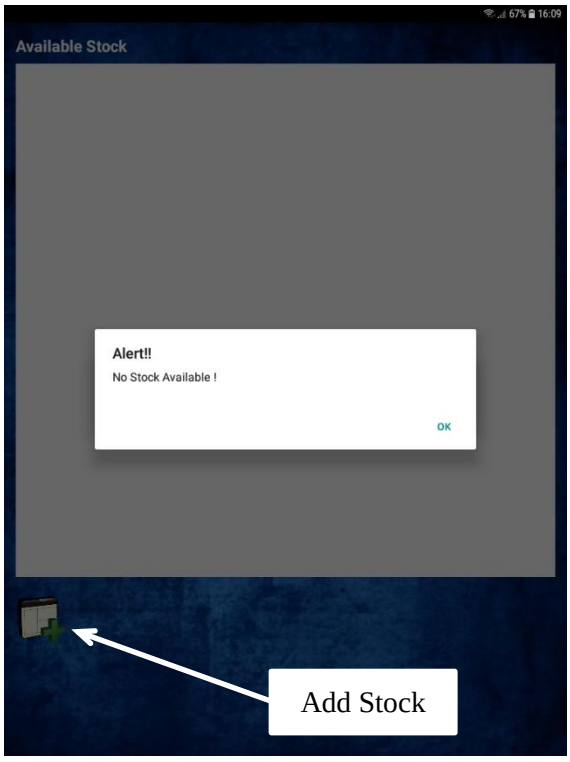


The app will show relevant account details of the entered account number. You can check the details and click the “View” button

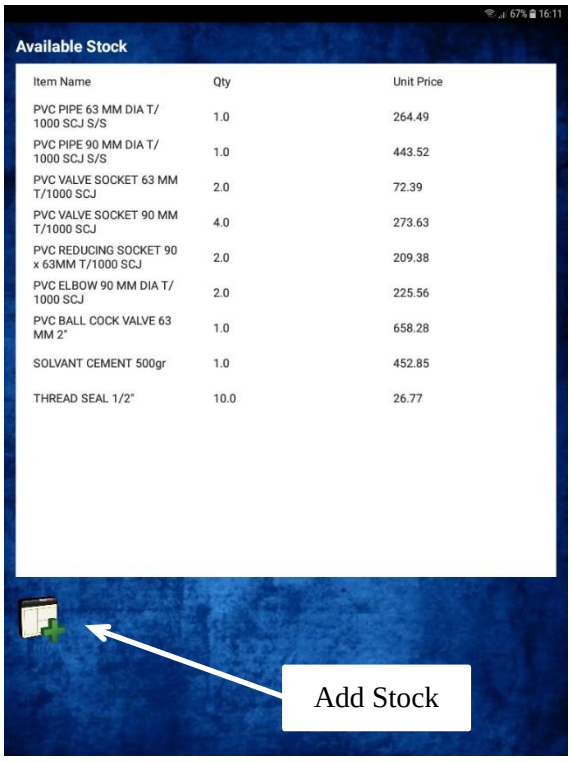


Here that app will show the GPS location of the relevant Account Number premises if available. You can use google navigation to go to this location. When press back it will redirect to the app screen

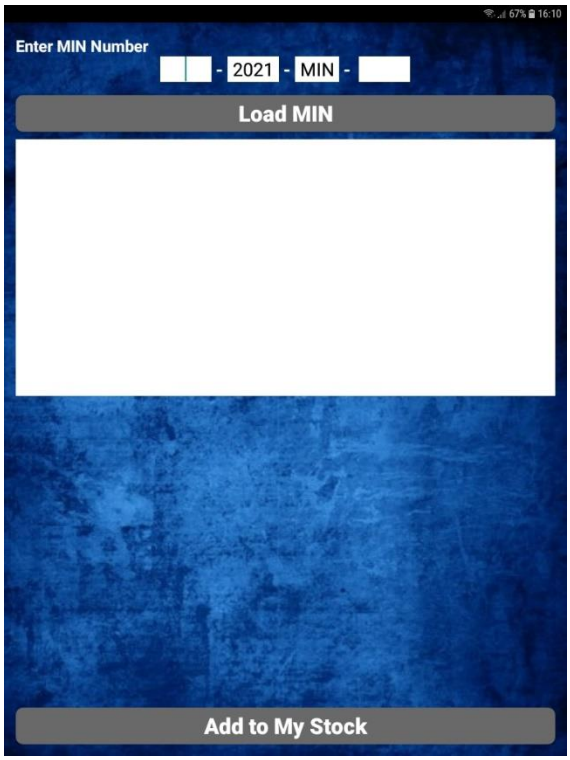
When you click on "Crew" icon app will direct you to this interface. Here you can see the crew members of your crew, their designations and hourly Rates When press back it will redirect to Home screen



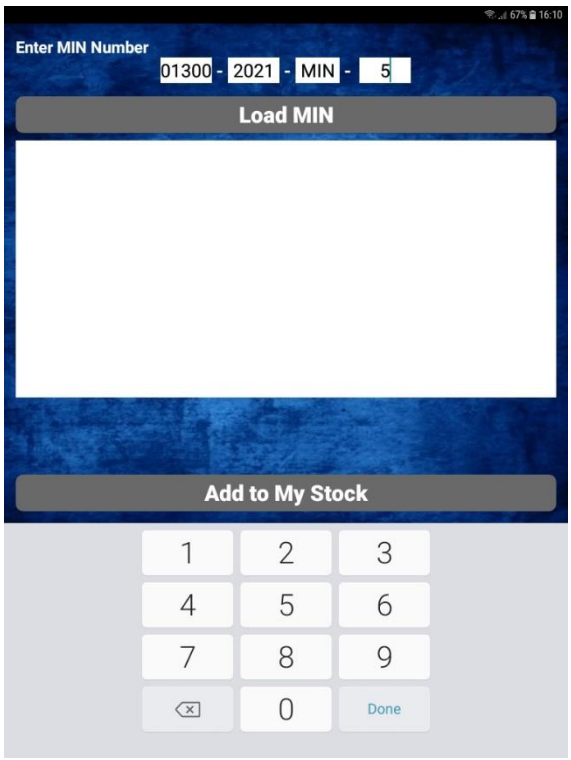
When you click on "Stock Management" icon app will direct you to this interface. IF you do not have any available stock under your crew it will prompt a "No Stock Available!" message



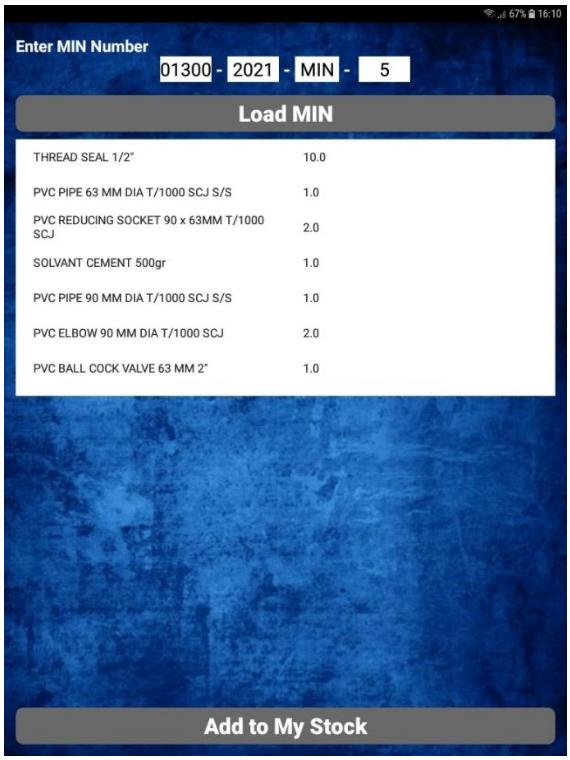
If you have any available stocks app will show all available stocks under your crew along with available quantity and current average price in IMS system. You can click "Add Stock" icon to add more stocks



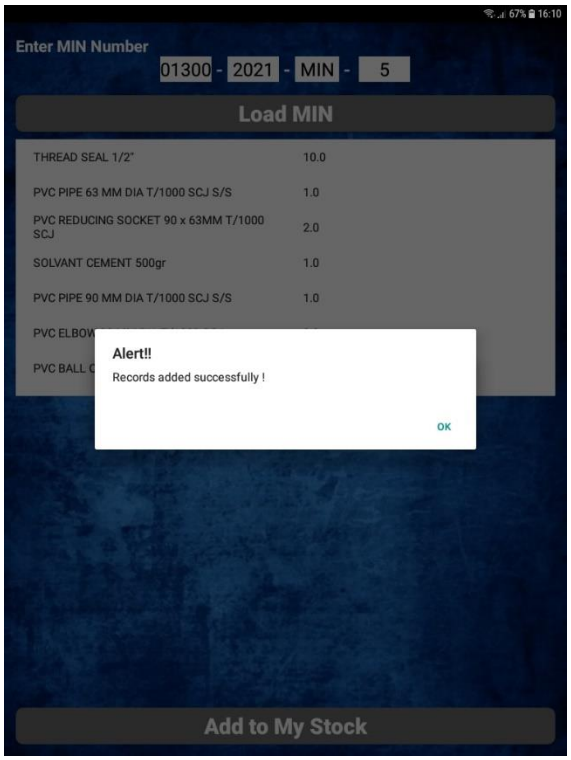
When you click on "Add Stock" icon app will direct you to this interface. Here you can enter the MIN number that you received the stock from IMS system



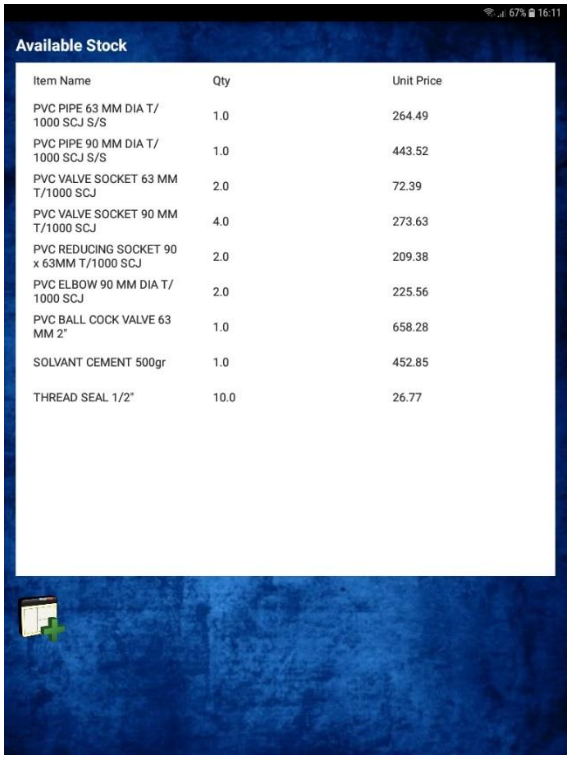
You can enter the MIN number in the given spaces and click "Load MIN" button



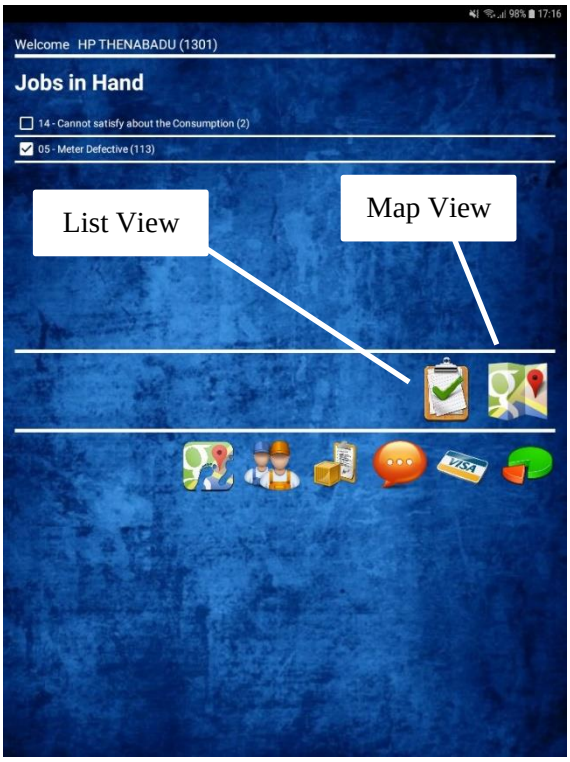
Then the app will load the items and the Quantities as shown. Then you can press "Add to my stock" button to add those items to your available stock



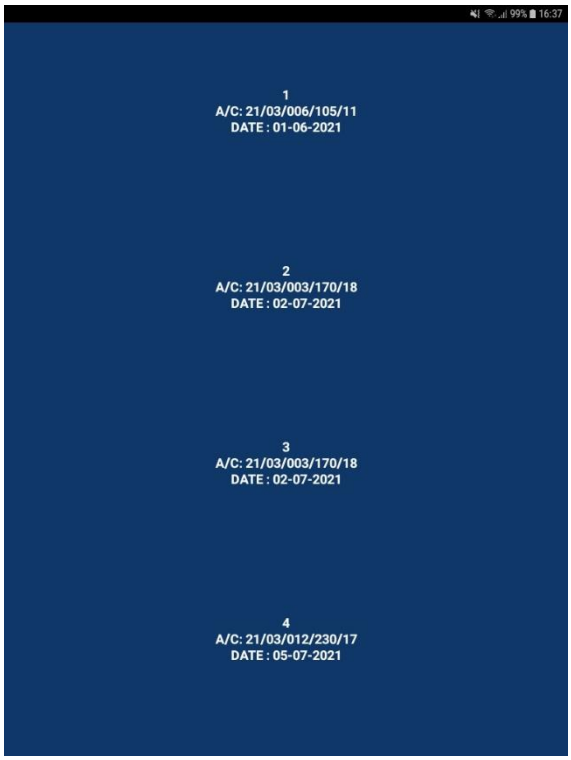
App will prompt "Record added successfully!" message



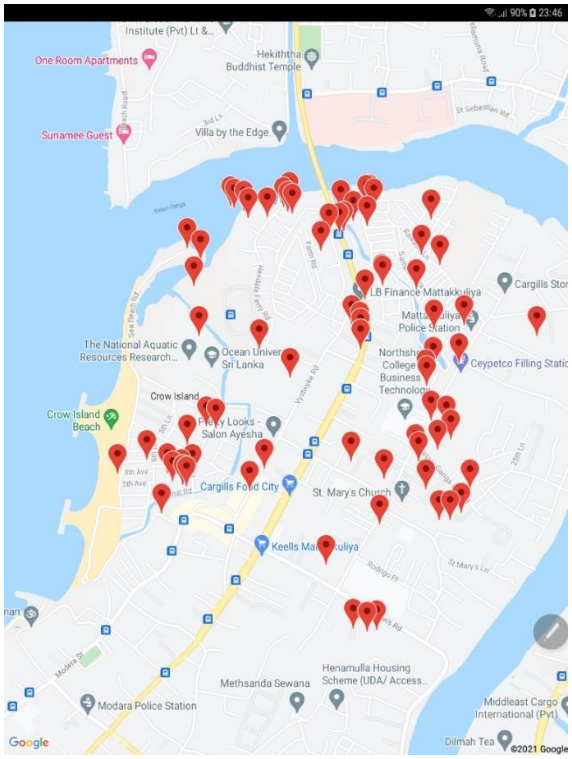
When you press back button in your device, those added stocks can be see in Available Stock interface



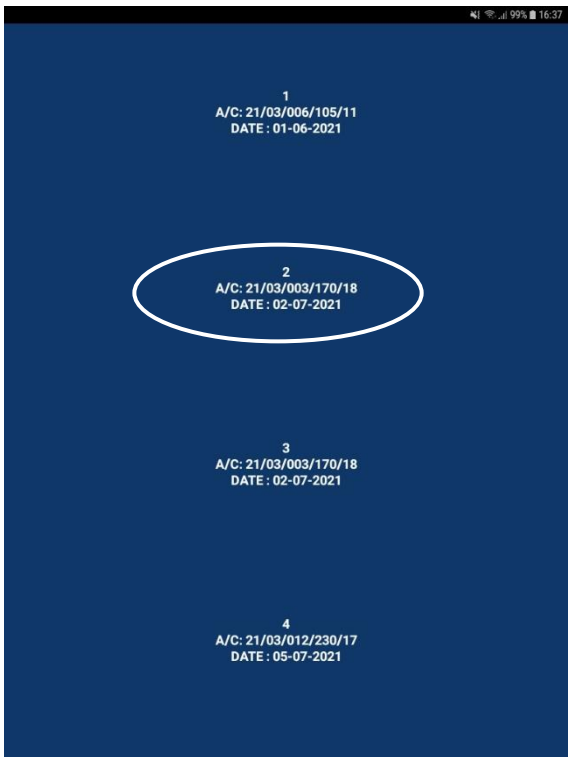
You can view the pending jobs in two separate methods, list view or map. Those options are labeled in this interface



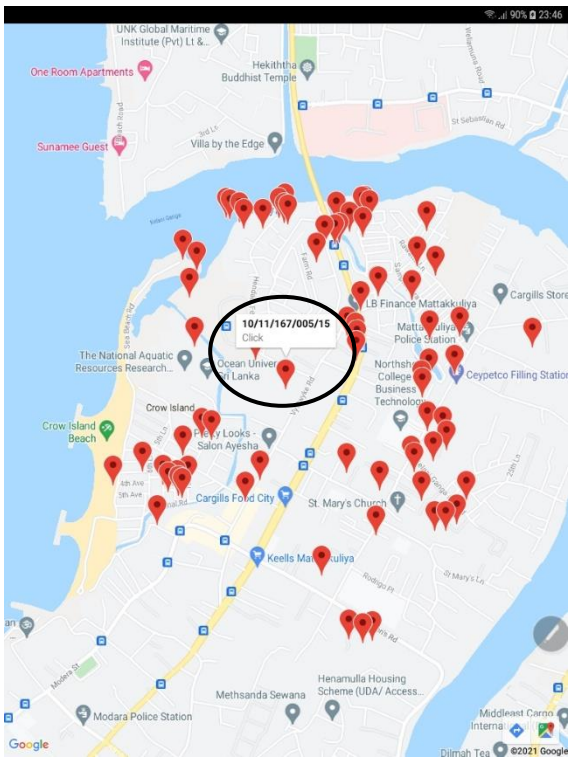
When you select the List view icon it will list out the jobs in ascending date order with Account number and Date. You can scroll it up and down and select a job to proceed



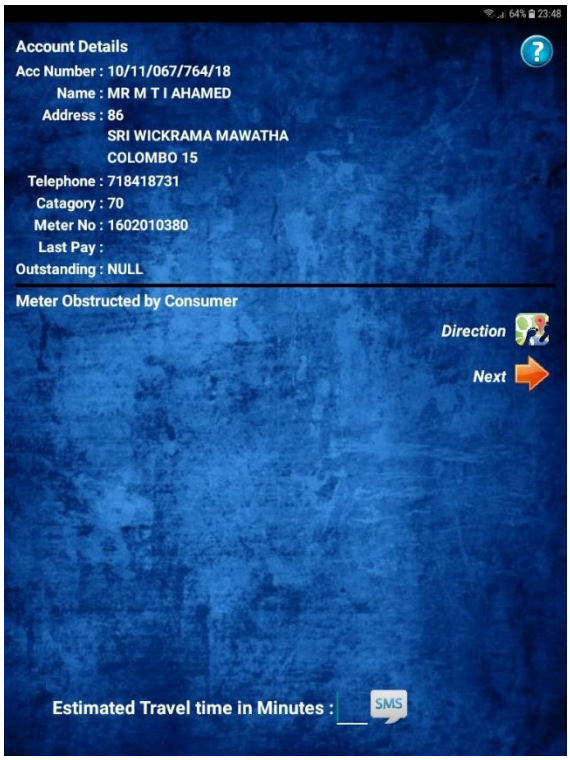
When you select the Map view icon it shows all the available GPS locations as shown in the interface. You can select a job to proceeds by considering the location



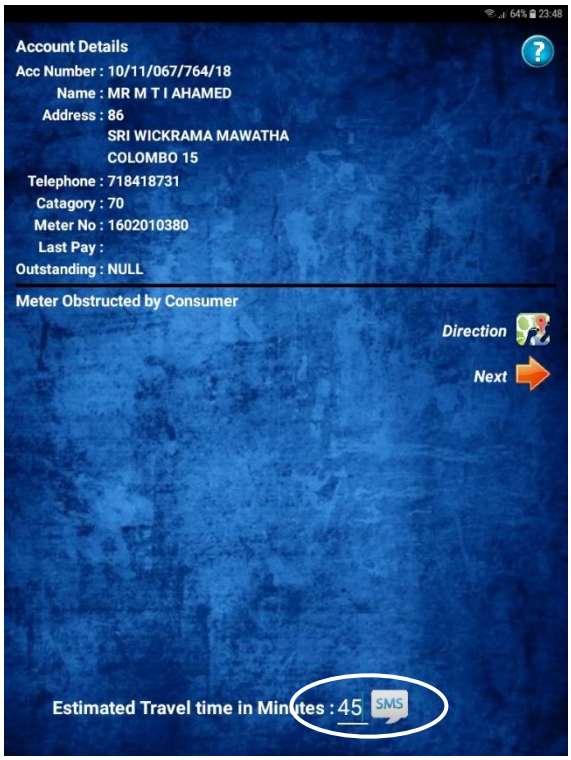
If you prefer list view you can select the job to proceed. This will direct to the Account Details interface



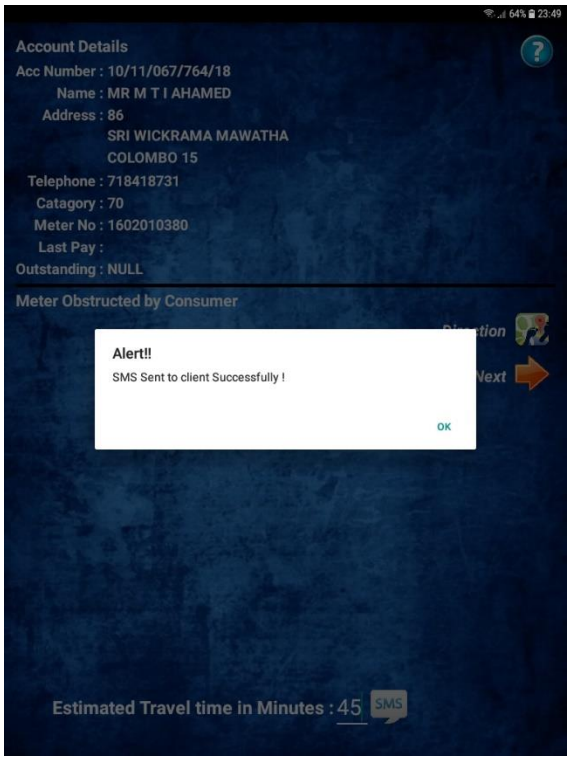
If you prefer map view you can select the job to proceed. This will also direct to the Account Details interface



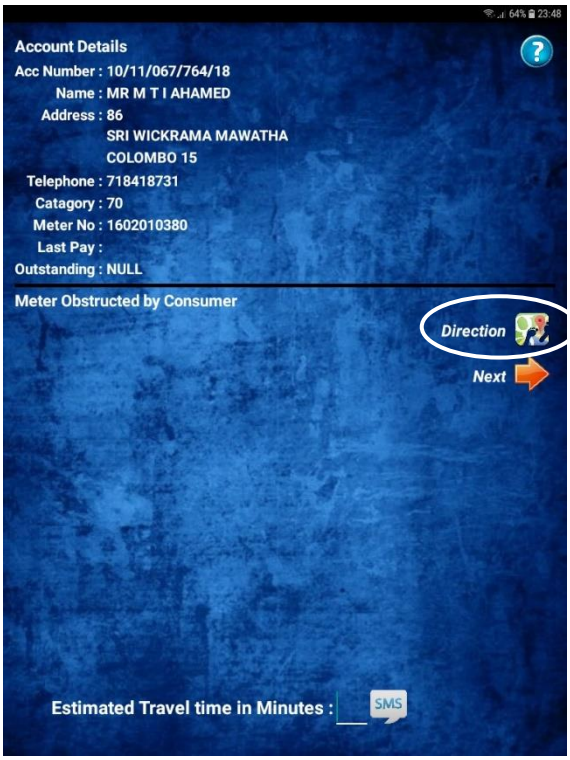
You can see the account details and customer details from this interface.



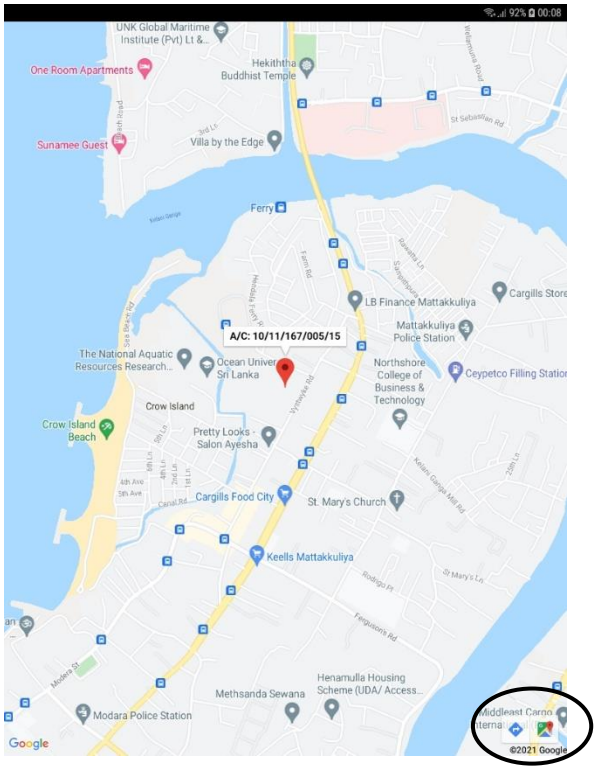
Here you can send SMS to the customer that you are going to visit if the mobile number is available. You can enter estimated time to travel in minutes and click “SMS” icon. The system will add those time to current date time and send client SMS with estimated time of visit



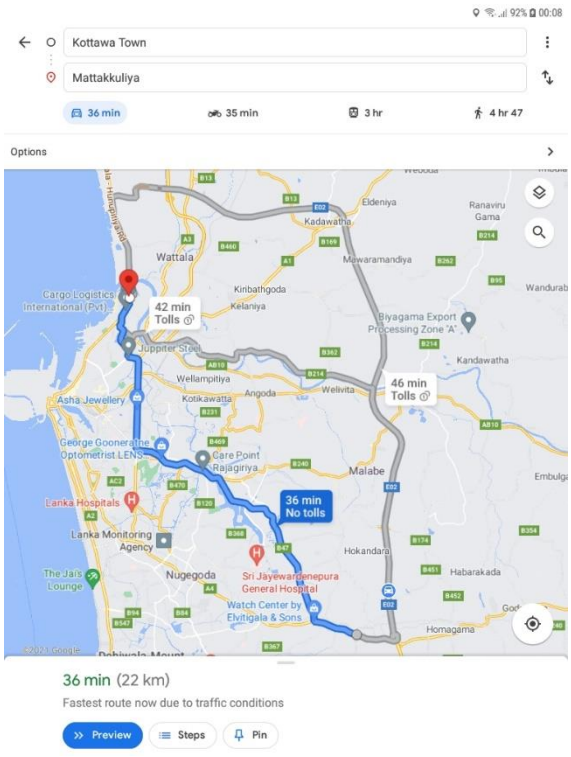
You can see the Success message



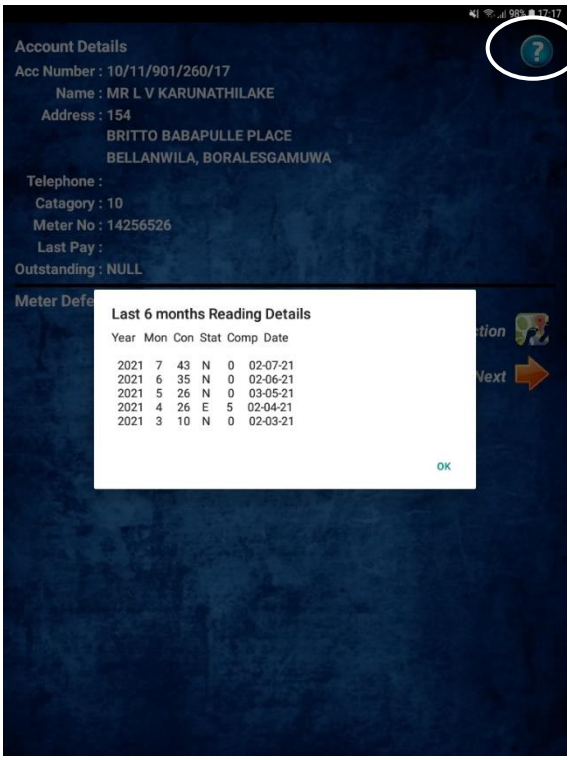
Use directions icon to view the location client in google map. You can use google navigation or other third-party navigation apps to navigate to the location



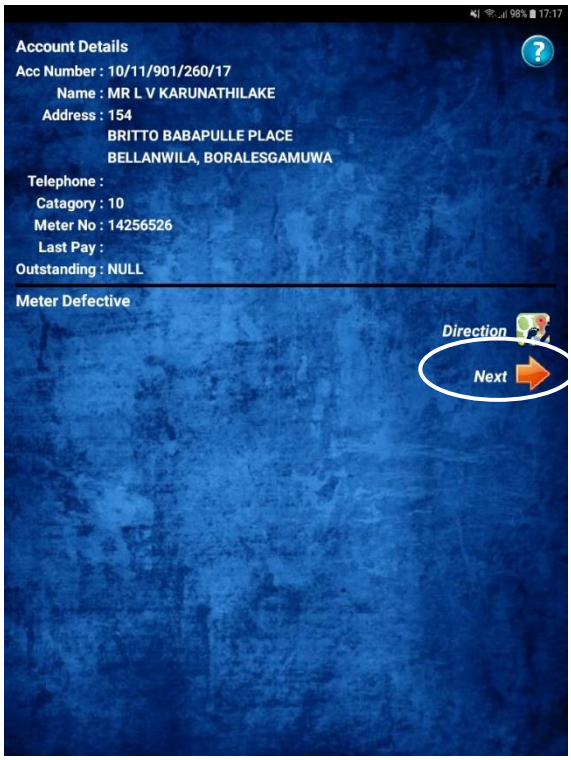
Select navigation apps to open it and navigate to the location



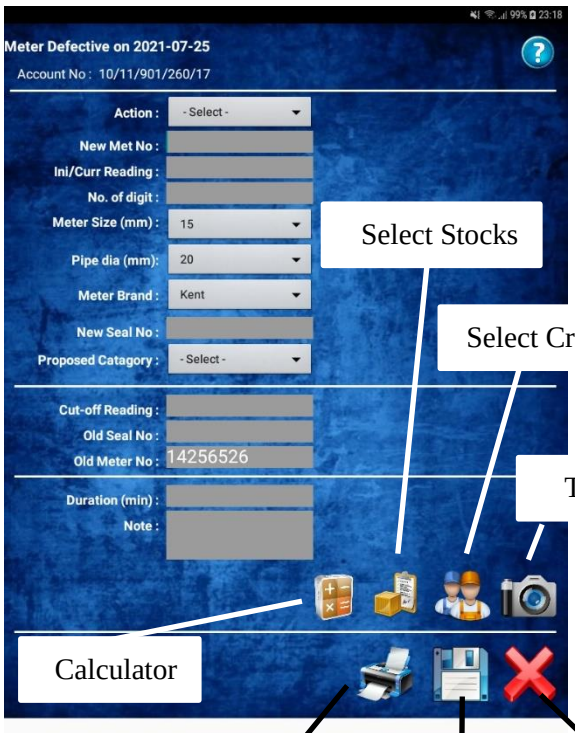
Navigate to the location and press back button when arrived



Clock the ? button for last six month reading details

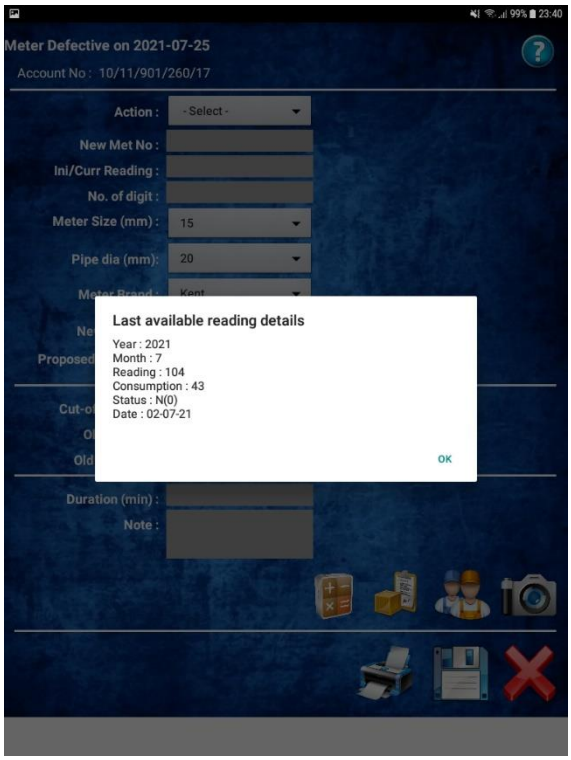


Select next to after finishing the job

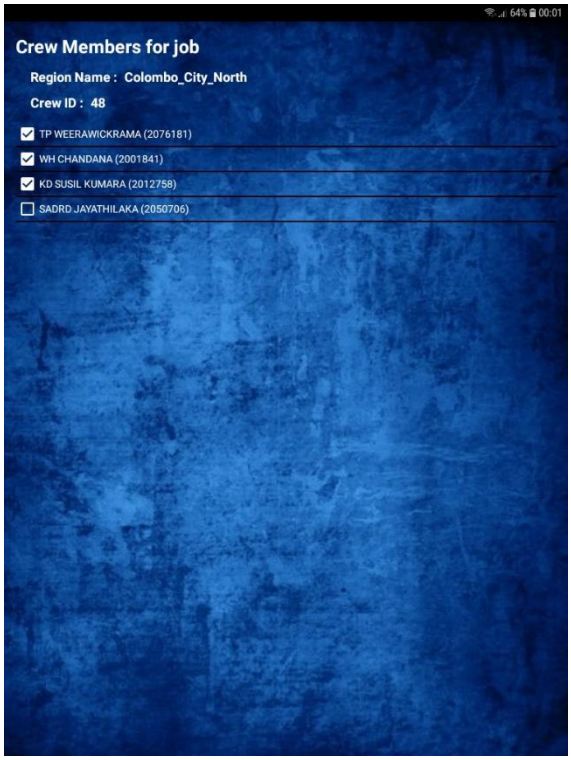


Use available options as necessary

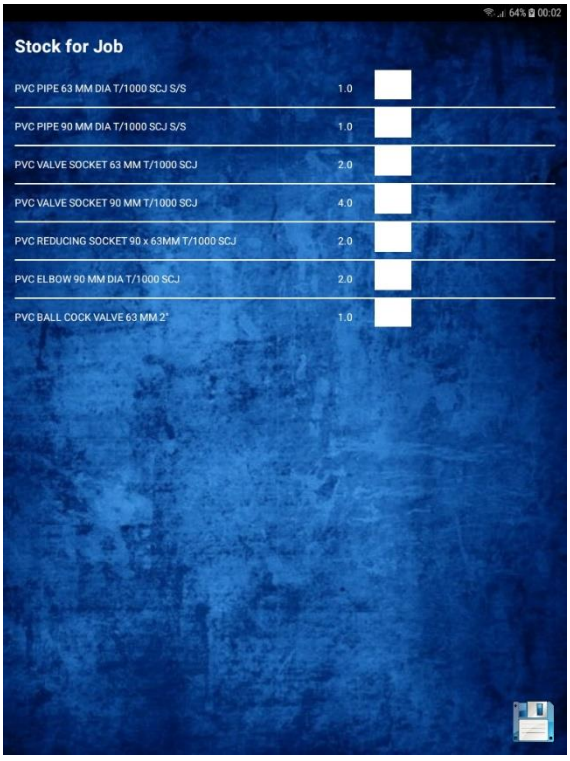
Fill the required fields according to the Action



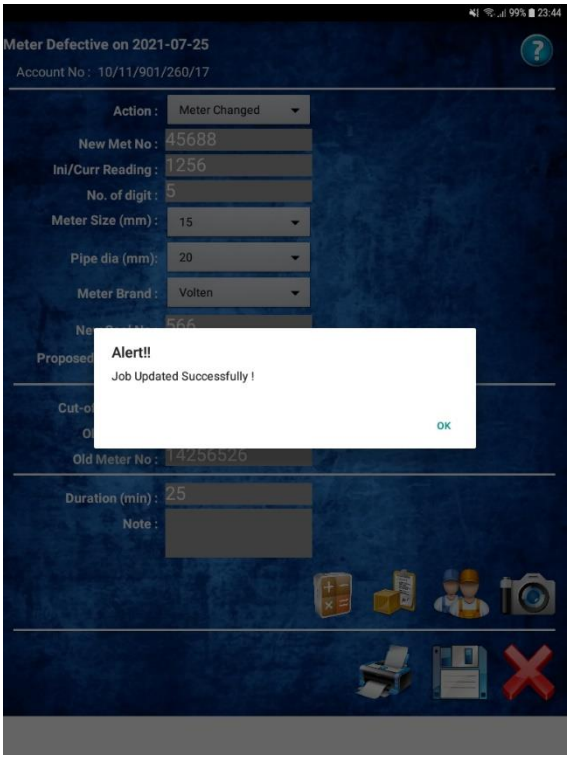
Clock the ? button for last reading details



When you click on “Select Crew” icon this interface will appear and you can select the crew members that attend to the job



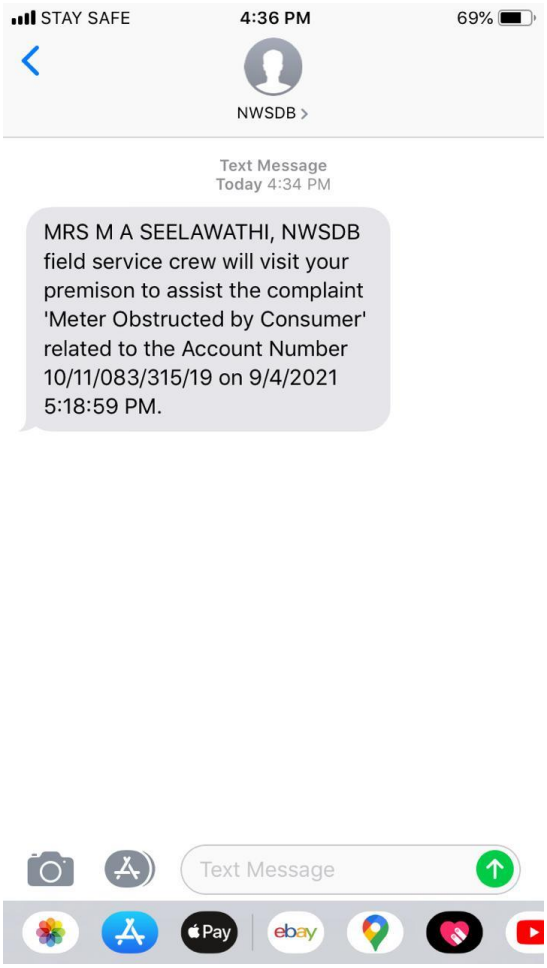
When you click on “Select Stock” icon this interface will appear and you can select the inventory items that the job consumed from available stocks



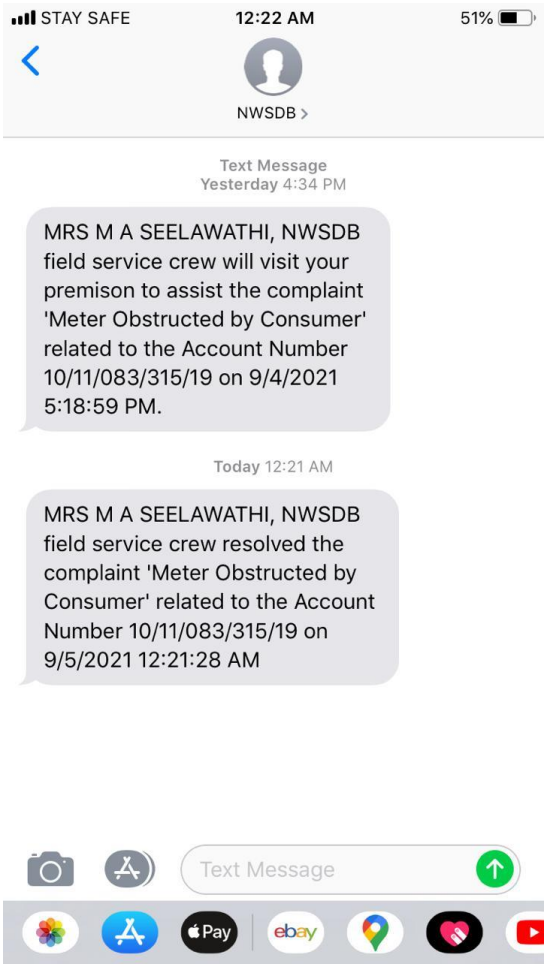
You can save the job after filling all the required fields and all the selected data will updated into the server and the complaint will marked as Completed. Client also received the job completion SMS

Customer SMS

When the crew select the job, enter estimated travel time and click “SMS” icon client will receive the following SMS 1 message. And When the crew finished the job customer will receive the following SMS 2 message.



SMS 1



SMS 2

Appendix C - MIS Reports

Project MIS Reports

Followings are the major MIS report and their definitions in this Meter Reader Complaint Management Mobile App and Metering Web Based System. These reports are based of the service performances, Inventory management, etc…

Meter Reader Complaint Job Calendar Report

This progress report is a calendar like report that explain the overall jobs. Here is this screen (Figure 1) shows the inputs that required to generate the report.

Report Inputs

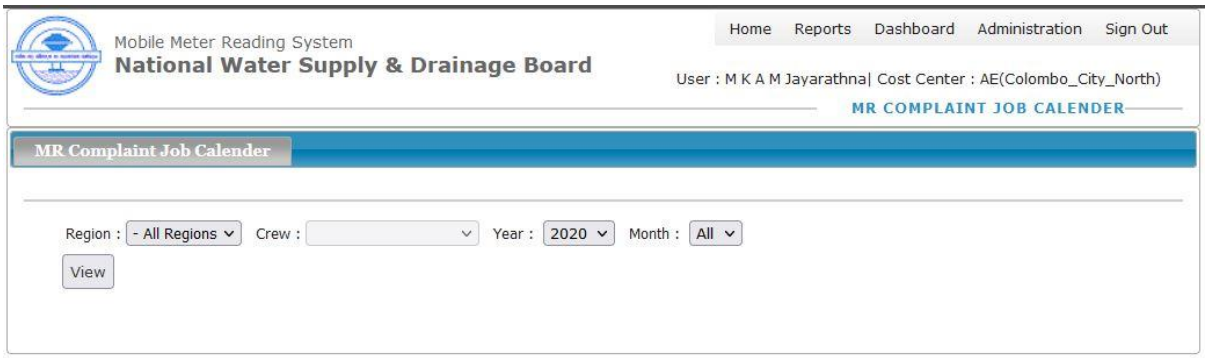


Figure C.1- Meter Reader Complaint Job Calendar Report Inputs

- Select Region
  - ✓ Admin – Optional
  - ✓ Manager – Compulsory (Only relevant region will show)
  - ✓ User - Compulsory (Only relevant region will show)
- Select Crew
  - ✓ Admin – Optional (Crews under relevant Region will show)
  - ✓ Manager – Optional (Crews under relevant Region will show)
  - ✓ User – Optional (Crews under relevant Region will show)
- Select Year
  - ✓ Admin – Compulsory (already selected year)
  - ✓ Manager – Compulsory (already selected year)
  - ✓ User – Compulsory (already selected year)
- Select Month
  - ✓ Admin – Compulsory (already selected year)
  - ✓ Manager– Compulsory (already selected year)
  - ✓ User – Compulsory (already selected year)

Report Format

Region Name	Crew Name	Month	Month	Total
		5	6	
Region 1	**Crew 1**	x	x	x
	Total	x	x	x
Total		x	x	x

- In this format heading Month become Dates then you select specific month.

Sample Report

Here (Figure 2) is a sample report for the region 'Colombo City North', year '2021' and Month '6'.

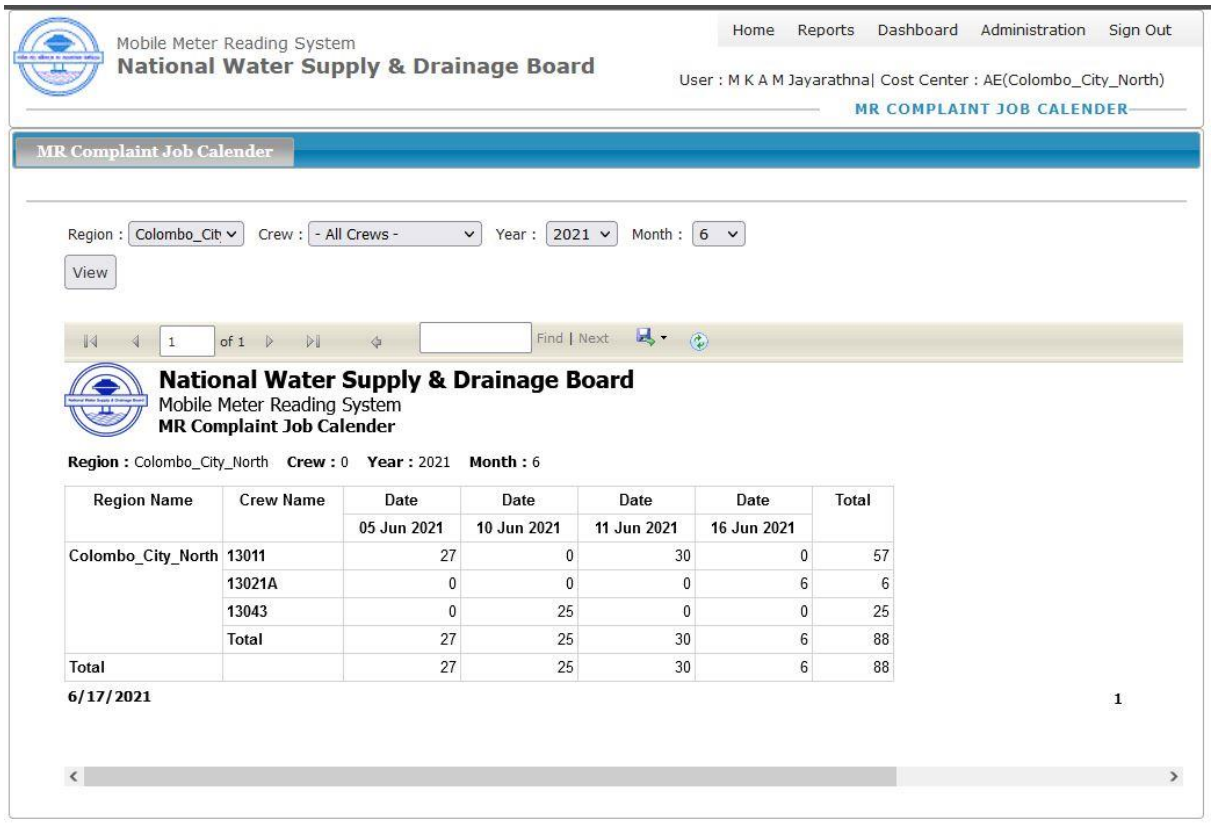


Figure C.2- Meter Reader Complaint Job Calendar Report

Management Information to Observe

- Work performances of each crew date vise or month vise.
- Identify work days of each crew
- Performance details of all the country or region in one report.

Meter Reader Complaint Progress Summary Report

This progress report is the summarized version of performances for each crew. Here is this screen shows the inputs that required to generate the report.

Report Inputs

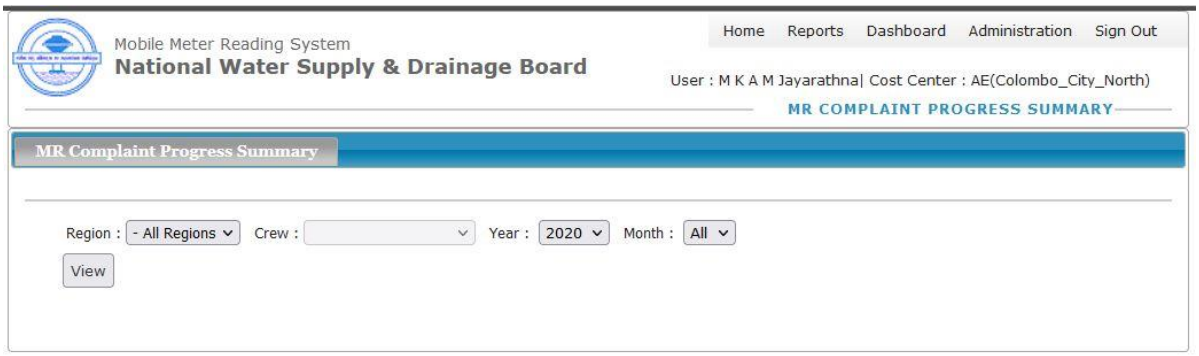


Figure C.3 - Meter Reader Complaint Progress Summary Inputs

- Select Region
  - ✓ Admin – Optional
  - ✓ Manager – Compulsory (Only relevant region will show)
  - ✓ User - Compulsory (Only relevant region will show)
- Select Crew
  - ✓ Admin – Optional (Crews under relevant Region will show)
  - ✓ Manager – Optional (Crews under relevant Region will show)
  - ✓ User – Optional (Crews under relevant Region will show)
- Select Year
  - ✓ Admin – Compulsory (already selected year)
  - ✓ Manager – Compulsory (already selected year)
  - ✓ User – Compulsory (already selected year)
- Select Month
  - ✓ Admin – Compulsory (already selected year)
  - ✓ Manager– Compulsory (already selected year)
  - ✓ User – Compulsory (already selected year)

Report Format

Region Name	Crew Name	Complaints (All)	Complaints (Done)	Complaints (Remaining)	Done Progress
Region 1	**Crew 1**	x	y	x-y	(y/x) *100 %
	Total	x	y	x-y	(y/x) *100 %
Total		x	y	x-y	(y/x) *100 %

Sample Report

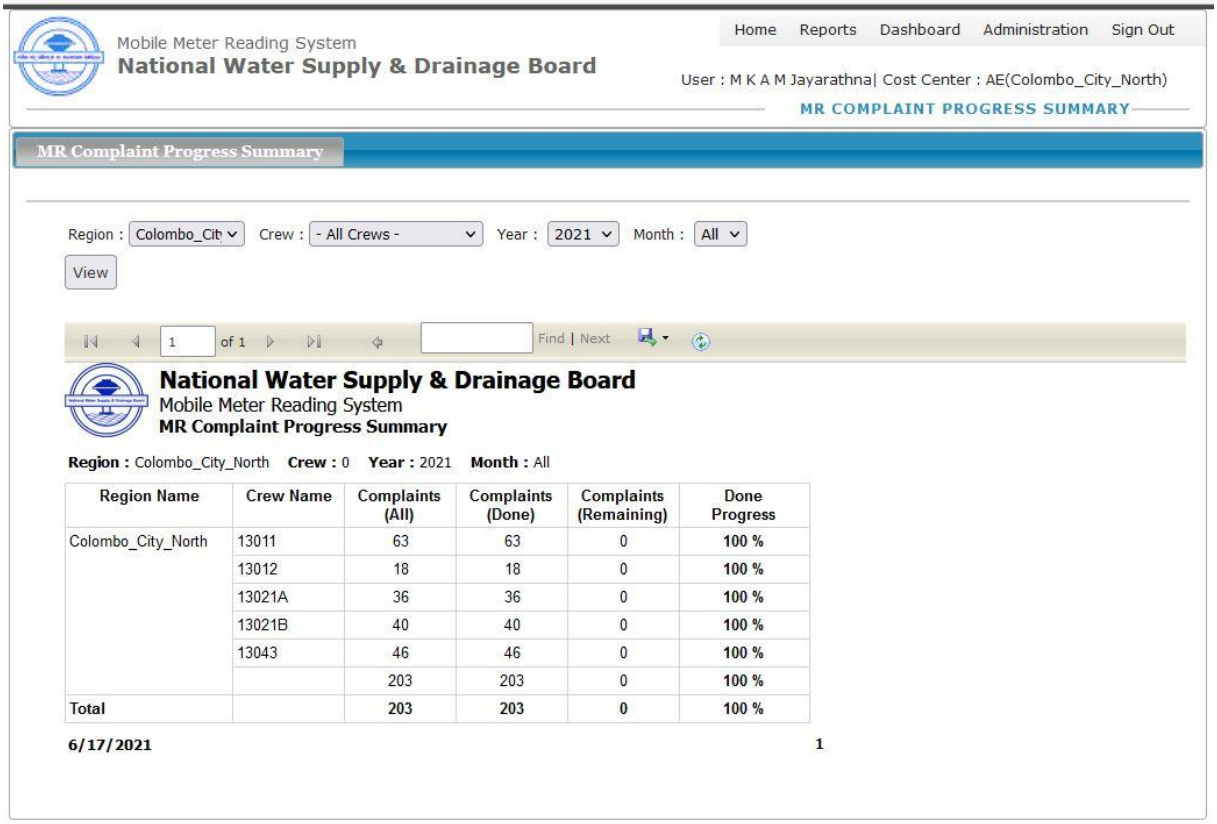


Figure C.4 - Meter Reader Complaint Progress Summary Report

Management Information to Observe

- Work performances of each crew as a percentage.
- No of completed and remaining jobs for each region and each crew.
- Island wide performance analysis with each region contribution from a single report.

Meter Reader Complaint Expenditure Summary Report

This progress report is the summarized version of inventory and Labor cost for each month for selected year. Here is this screen shows the inputs that required to generate the report.

Report Inputs

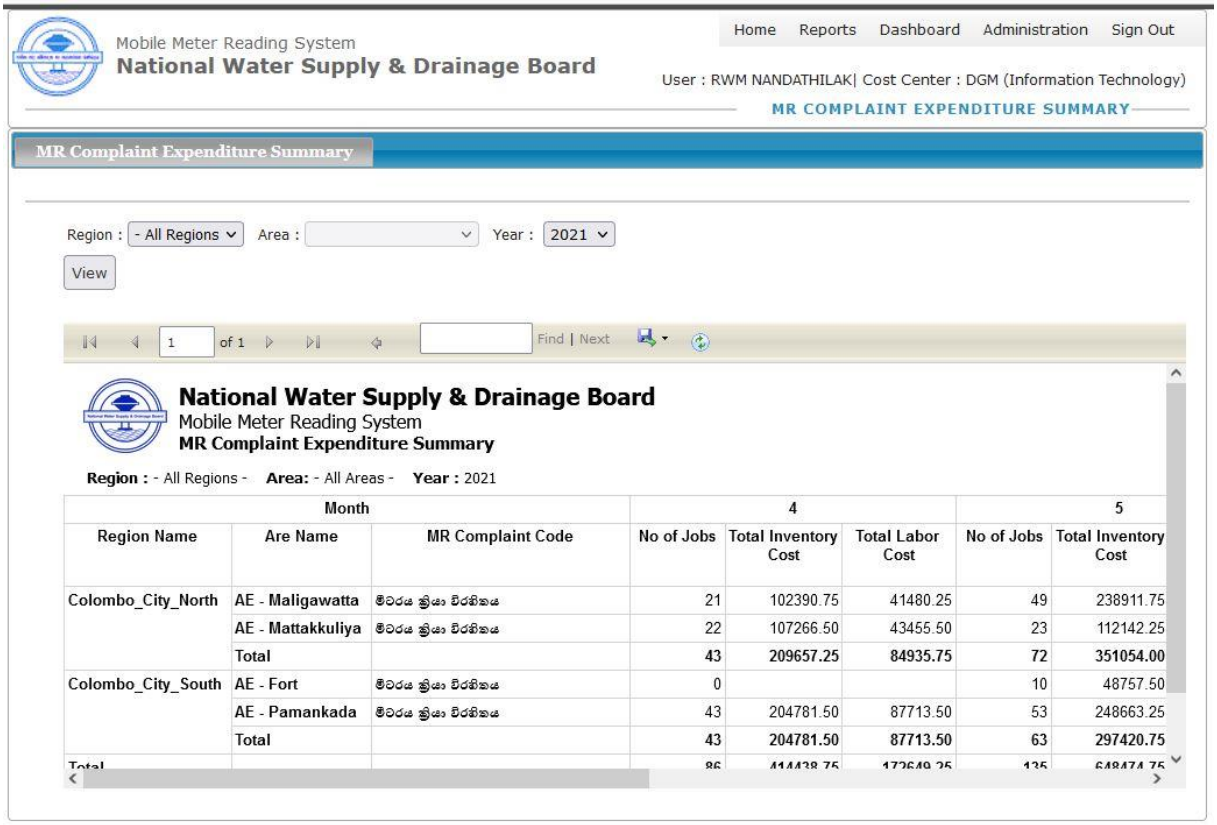
Figure C.5 - Meter Reader Complaint Expenditure Summary Inputs

- Select Region
  - ✓ Admin – Optional
  - ✓ Manager – Compulsory (Only relevant region will show)
  - ✓ User - Compulsory (Only relevant region will show)
- Select Area
  - ✓ Admin – Optional (Areas under relevant Region will show)
  - ✓ Manager – Optional (Areas under relevant Region will show)
  - ✓ User – Optional (Areas under relevant Region will show)
- Select Year
  - ✓ Admin – Compulsory (already selected year)
  - ✓ Manager – Compulsory (already selected year)
  - ✓ User – Compulsory (already selected year)

Report Format

Month			5			6			Total		
Region Name	**Area Name**	**MR Complaint Code**	x	x	x	x	x	x	**x**	**x**	**x**
Region 1	**Area 1**	**Code 1**									
		Code 2									
		Total									
	Area 2	**Code 1**									
		Code 2									
		Total									
Total											

Sample Report



Month			4			5	
Region Name	Are Name	MR Complaint Code	No of Jobs	Total Inventory Cost	Total Labor Cost	No of Jobs	Total Inventory Cost
Colombo_City_North	AE - Maligawatta	මිටරය කියවා වැරණිකය	21	102390.75	41480.25	49	238911.75
	AE - Mattakkuliya	මිටරය කියවා වැරණිකය	22	107266.50	43455.50	23	112142.25
	Total		43	209657.25	84935.75	72	351054.00
Colombo_City_South	AE - Fort	මිටරය කියවා වැරණිකය	0			10	48757.50
	AE - Pamankada	මිටරය කියවා වැරණිකය	43	204781.50	87713.50	53	248663.25
	Total		43	204781.50	87713.50	63	297420.75
Total			86	414438.75	172649.25	135	648474.75

Figure C.6 - Meter Reader Complaint Expenditure Summary Report

Management Information to Observe

- Total Inventory expenditure of each month of the year along with Region, Area and MR Complaint code.
- Total Labor expenditure of each month of the year along with Region, Area and MR Complaint code.
- Island wide expenditure analysis with each Region, Area and MR Complaint code.

Appendix D - User Evaluation Form

This is the format of the google forms that was created to capture the user feedback online.

	Questions	Answers				
1	Name with Initials					
2	Designation	Manager Engineer System Administrator Officer in charge Commercial officer Engineer assistant Other				
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
	Appearance					
3	User Interfaces are attractive					
4	Colors that used are appropriate for any environment					
5	Font type and size are suitable					
6	used tools such as buttons and combo boxes are appropriate					
	Usability					
7	Navigation methods are easy to understand					
8	Map view and List view are helpful					
9	Tips and helps are available					
10	data validation and constraint are up to the pint					
	Functionality					
11	Workflow in accurate					
12	All the functionalities that required are available					
13	All the work-related details are provided					
14	Able to provide satisfactory output to the consumers					

	Performance					
15	Response time for request is sufficient					
16	Smoothly runs with third party applications					
17	Work well in background and do not lost the state					
18	Works fine with huge amount of data					
	Security					
19	Login and Logout works fine					
20	Can access relevant jobs only					
21	Can access relevant Inventory information only					
22	Can access relevant labor information only					

Figure D. 1 - User Evaluation Form

Meter Reader Complaint Management Mobile App

18 responses

Publish analytics

Name with Initials

18 responses

M D A Wanaguru

Sadeep Dananjaya

Prabudda Perera

M Sadamaali

S Thennakoon

A H Peeris

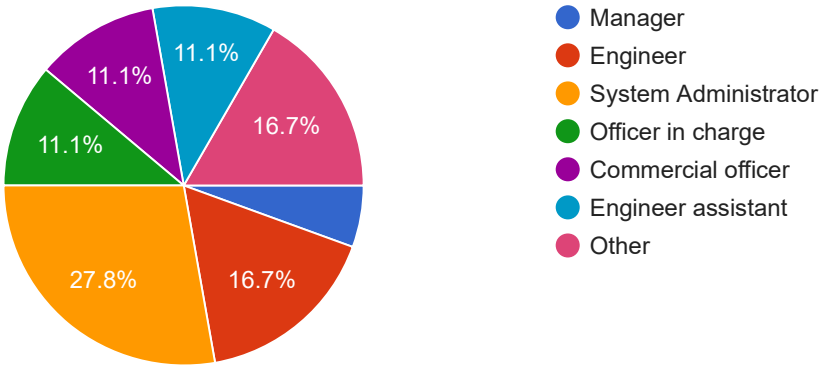
M H S P Kumara

K.Tharanga Kariyawasam

R S Nayomi

Designation

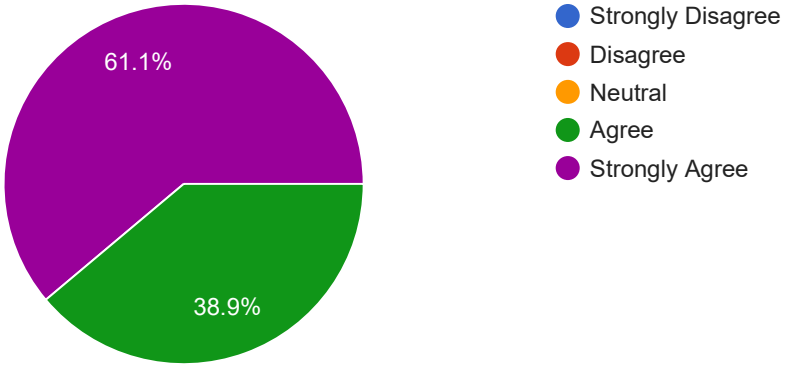
18 responses



Appearance

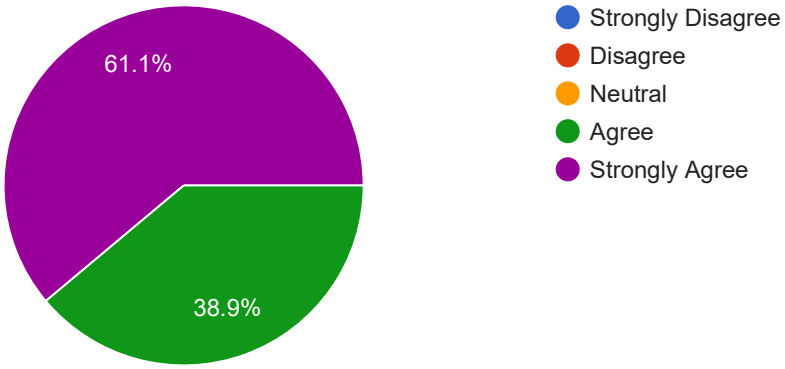
User Interfaces are attractive?

18 responses



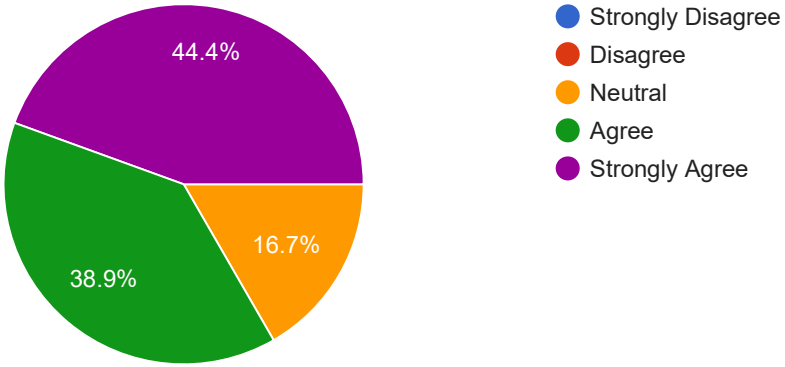
Colors that used are appropriate for any environment

18 responses



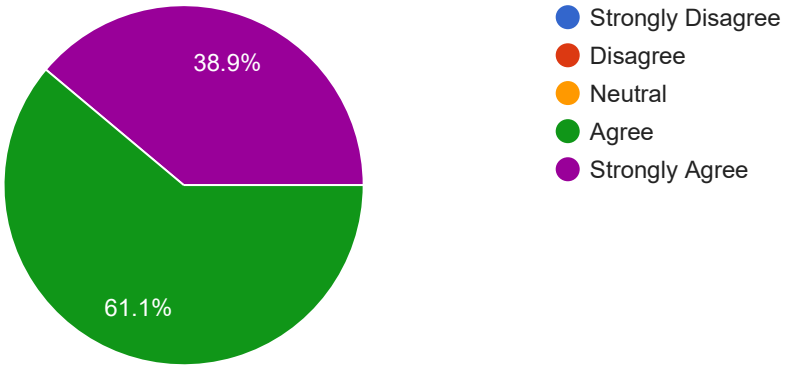
Font type and size are suitable

18 responses



used tools such as buttons and combo boxes are appropriate

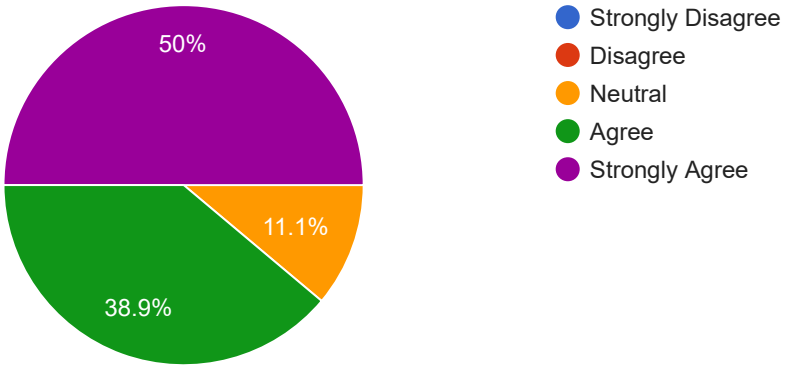
18 responses



Usability

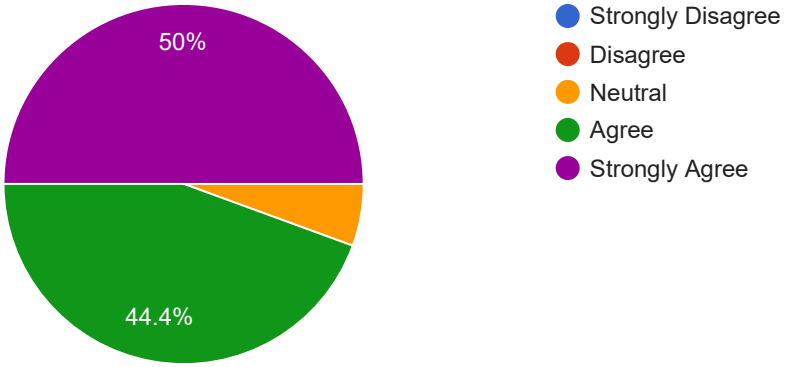
Navigation methods are easy to understand

18 responses



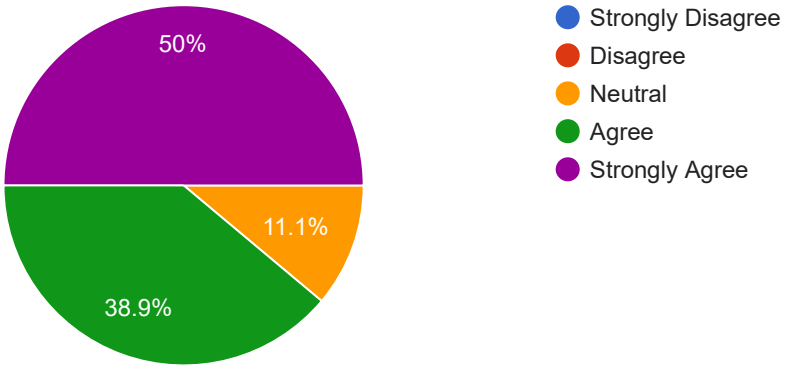
Map view and List view are helpful

18 responses



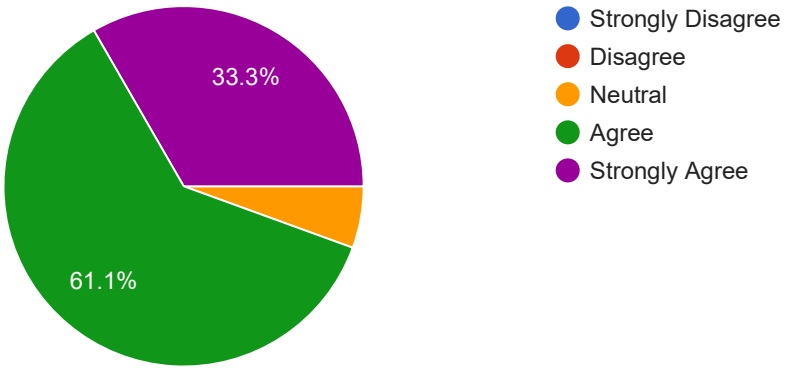
Tips and helps are available

18 responses



data validation and constraint are up to the pint

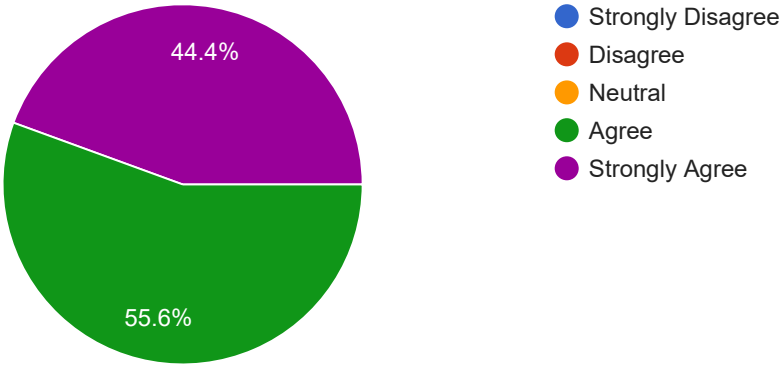
18 responses



Functionality

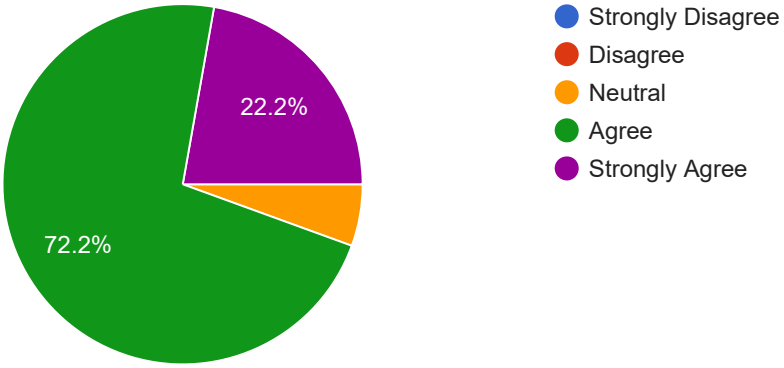
Workflow in accurate

18 responses



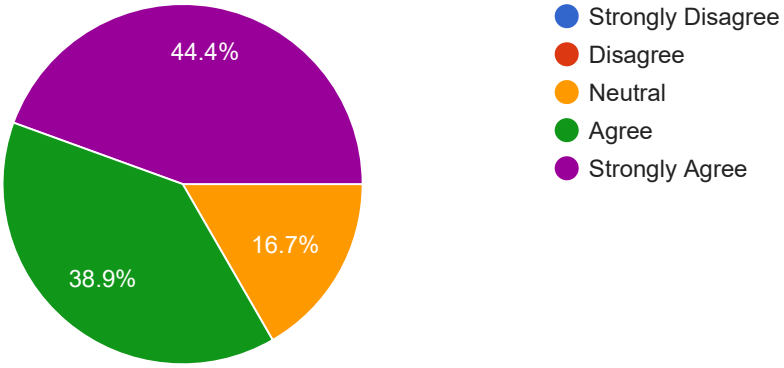
All the functionalities that required are available

18 responses



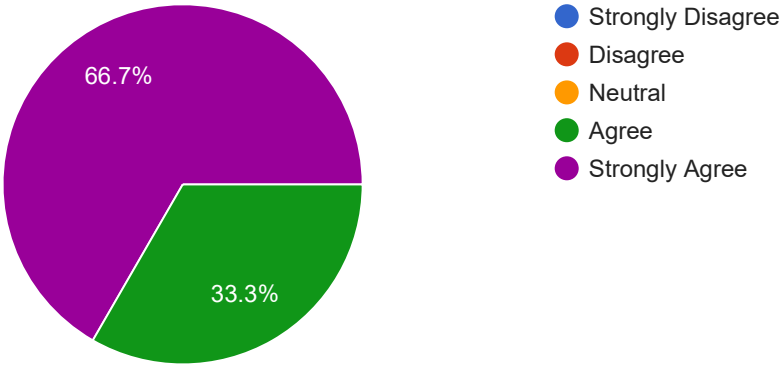
All the work related details are provided

18 responses



Able to provide satisfactory output to the consumers

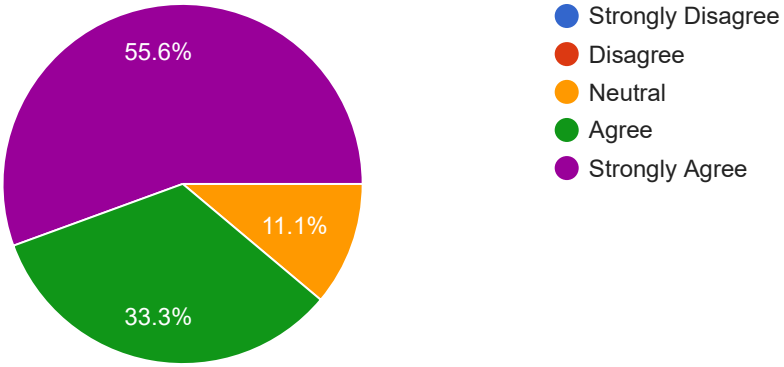
18 responses



Performance

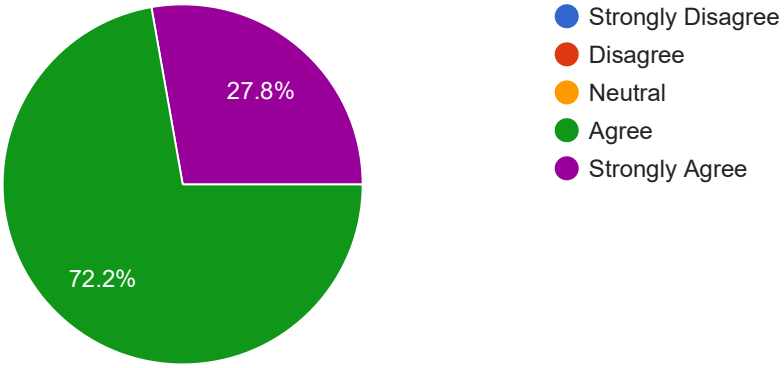
Response time for request is sufficient

18 responses



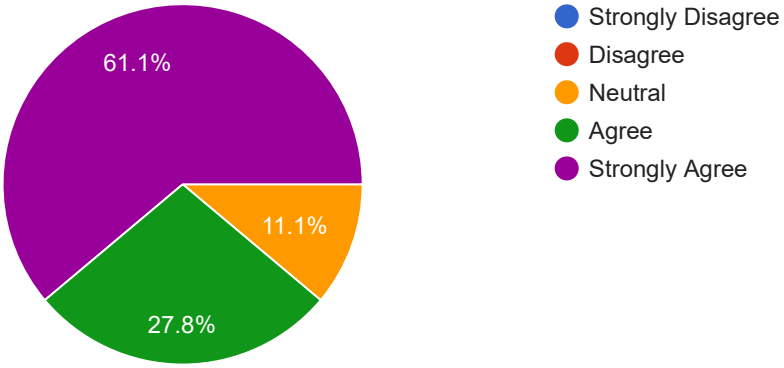
Smoothly runs with third party applications

18 responses



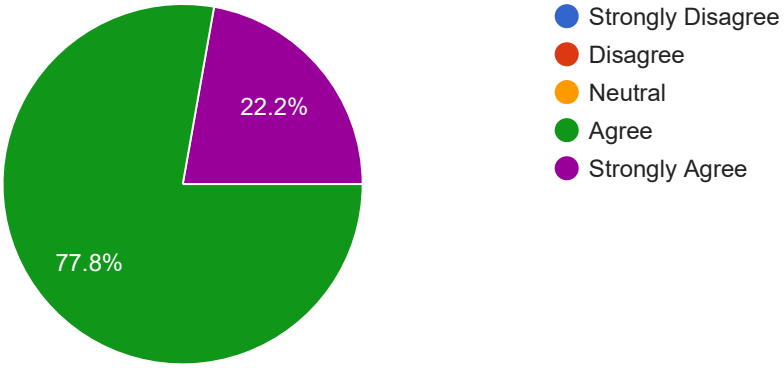
Work well in background and do not lost the state

18 responses



Works fine with huge amount of data

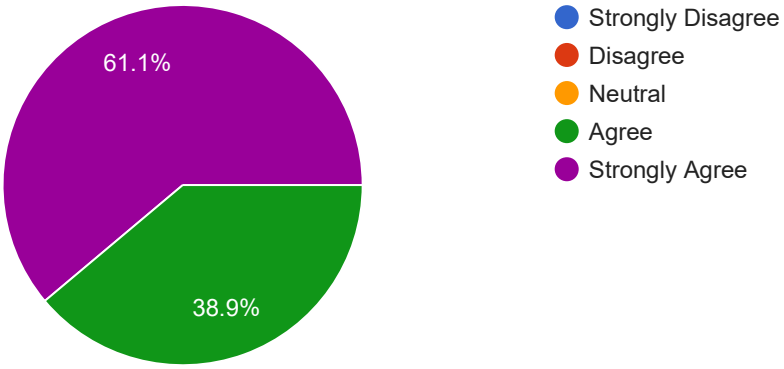
18 responses



Security

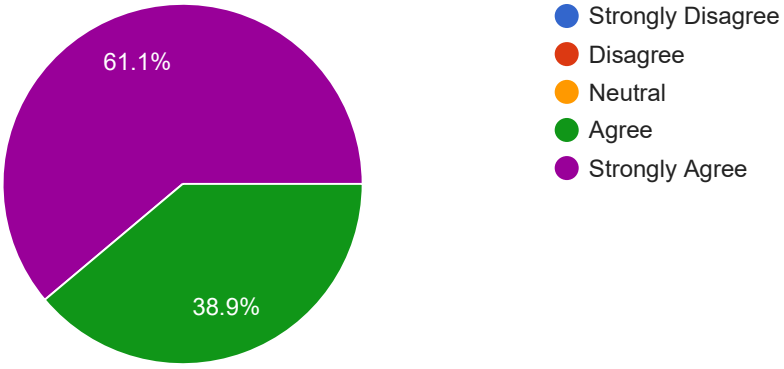
Login and Logout works fine

18 responses



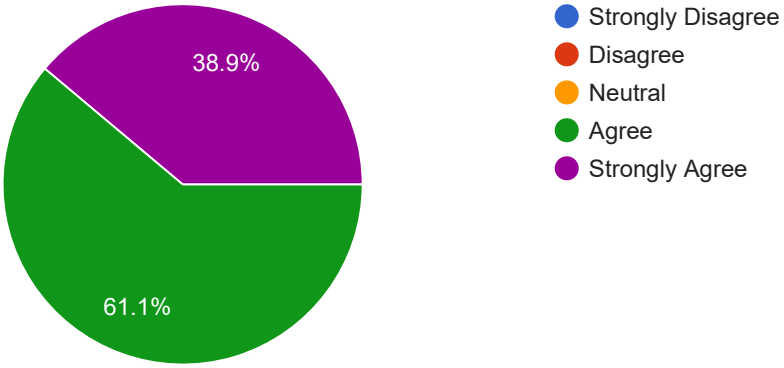
Can access relevant jobs only

18 responses



Can access relevant Inventory information only

18 responses



Can access relevant labor information only

18 responses