A WIRELESS WATER POLLUTION MONITORING SYSTEM

MUHAMMAD ASYRAF BIN OTHMAN

BACHELOR OF COMPUTER SCIENCE

UNIVERSITI MALAYSIA PAHANG

UNIVERSITI MALAYSIA PAHANG

DECLARATION OF THESIS AND COPYRIGHT

Author's Full Name : ____________________

Date of Birth : ____________________

Title : ____________________

____

____

Academic Session : ____________________

I declare that this thesis is classified as:

- ☐ CONFIDENTIAL (Contains confidential information under the Official Secret Act 1997)*
- ☐ RESTRICTED (Contains restricted information as specified by the organization where research was done)*
- ☑ OPEN ACCESS I agree that my thesis to be published as online open access (Full Text)

I acknowledge that Universiti Malaysia Pahang reserves the following rights:

1. The Thesis is the Property of Universiti Malaysia Pahang
2. The Library of Universiti Malaysia Pahang has the right to make copies of the thesis for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

_______________	_______________
(Student's Signature)	(Supervisor's Signature)
_______________	_______________
New IC/Passport Number Date:	Name of Supervisor Date:

NOTE : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach a thesis declaration letter.

THESIS DECLARATION LETTER (OPTIONAL)

Librarian,
Perpustakaan Universiti Malaysia Pahang,
Universiti Malaysia Pahang,
Lebuhraya Tun Razak,
26300, Gambang, Kuantan.

Dear Sir,

CLASSIFICATION OF THESIS AS RESTRICTED

Please be informed that the following thesis is classified as RESTRICTED for a period of three (3) years from the date of this letter. The reasons for this classification are as listed below.

Author's Name
Thesis Title

Reasons (i)

(ii)

(iii)

Thank you.

Yours faithfully,

____
(Supervisor's Signature)

Date:

Stamp:

Note: This letter should be written by the supervisor, addressed to the Librarian, *Perpustakaan Universiti Malaysia Pahang* with its copy attached to the thesis.

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and, in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Computer Science(Computer Systems & Networking)

____

(Supervisor's Signature)

Full Name :

Position :

Date :

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

____

(Student's Signature)

Full Name : MUHAMMAD ASYRAF BIN OTHMAN

ID Number : 940322015265

Date : 9 January 2019

A WIRELESS WATER POLLUTION MONITORING SYSTEM

MUHAMMAD ASYRAF BIN OTHMAN

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Computer System and Networking With Honour

Faculty of Computer System & Software Engineering
UNIVERSITI MALAYSIA PAHANG

JANUARY 2019

ACKNOWLEDGEMENTS

I want to offer my thanks and thankfulness to each one of the individuals who gave me the possibility to finish this report. A special thanks to our final year project coordinator, Encik Mohd Arfian Bin Ismail, whose help, giving suggestions and encouragement, helped me to coordinate my project especially in writing this report.

First and foremost, I would like to thank my supervisor Dr. Nor Syahidatul Nadiah Ismail . Thank you, madam, for providing me with fully supervision and direction from the start until the end of the project. The project would not be able to complete on time without madam's contribution from behind.

Lastly, I would like to thank my friend and family who always gave me a support or help. Without the understanding and concern from all the individuals mentioned, this project would not be accomplished.

ABSTRAK

Pada masa kini, pencemaran air merupakan ancaman yang serius bukan sahaja terhadap alam sekitar dan ekologi tetapi juga memberi kesan kepada manusia. Sebelum ini, mengesan dan memantau air hanya dilakukan secara manual dengan membawa sampel dari sungai atau laut ke makmal. Projek ini mencadangkan sistem pemantauan pencemaran air tanpa wayar. Selain itu, sistem ini bertujuan agar kakitangan Jabatan Alam Sekitar memantau sungai dengan lebih cekap dan mengurangkan beban kerja semasa pemantauan. Sistem ini disepadukan dengan reka bentuk alat pengesan untuk memantau kualiti dan pencemaran di atas air. Sistem ini menggunakan Arduino R3 untuk menyokong alat pengesan. Penggunaan sensor untuk projek ini ialah sensor Ph, sensor kekeruhan dan sensor aliran air. Peranti GSM berfungsi sebagai sambungan antara sensor dan aplikasi. Sistem ini juga akan menghantar semua maklumat yang dikumpul dari alat pengesan ke applikasi web melalui internet. Kakitangan boleh memantau sungai menggunakan aplikasi web yang akan menunjukkan hasil kualiti air. Selain itu, sistem ini juga memberikan tindakan yang perlu diambil untuk mengurangkan pencemaran air yg berlaku. Kakitangan juga boleh memperoleh data yang dikumpul sebelum ini oleh system digunakan untuk analisis dan kegunaan pada masa depan. Metodologi yang dipilih untuk projek ini adalah model waterfall kerana metodologi yang jelas dan tepat. Dalam membangun system pemantau pencemaran air, Notepad++ dan Arduino Software (IDE) digunakan untuk membangunkan antara muka dan fungsi yang memenuhi keperluan pengguna. Pada akhir projek ini, diharapkan WWPMS memenuhi keperluan pengguna. Oleh itu, aplikasi ini dapat memberikan cara yang mudah untuk memantau sungai yang tercemar.

ABSTRACT

Nowadays, water pollution is a serious threat not only to the environment and ecology but also effect the human as well. Before this, detecting and monitoring water only conduct manually by bringing sample from the river or sea to the lab. This project proposes a wireless water pollution monitoring system. Furthermore, this system are purposed to the staff of Jabatan Alam Sekitar to monitor the river more efficiently and reduces the workload during monitoring. This system integrated with sensors design to monitor the quality and pollution on the water. This system uses Arduino R3 to support and generate the sensors. The sensor use for this project is Ph sensor, Turbidity sensor and Flow sensor. The GSM devices acts as a connection between sensor and web application. This system also will pass all the information gather from the sensor to the web application via internet. The staff can monitor the river using the web application that will show the result of the water quality. Others, the system also provide an action taken to reduces the pollution base on the result of the water quality. Staff also can view data collected in form of graph by the system to use it to do analysis for future event. The methodology chosen for this project is Waterfall model which is well defined methodology and precise. In developing Wireless Water Pollution Monitoring system, Notepad++ and Arduino Software (IDE) are used to develop the interface and function that meet the requirement. In the end of this project, it is expected that the WWPMS meet the user requirement. Therefore, this application can give a convenient way to monitor the polluted river.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

WWPMS	Wireless Water Pollution Monitoring System
UWSN	Underwater Wireless Sensor Network
PIC	Programmed Interface Controllers
PH	Potential Hydrogen
GSM	Global System for Mobile Communication
WiMax	Worldwide Interoperability for Microwave Access
NTU	Nephelometric Turbidity Units
DO	Dissolved Oxygen

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Water is the most important thing in human life for survival. Also, water is an essential habitation for life ecosystem. With the rapid development of industry and economy of the countries more waste from the industrial are discharged into the water such as river or sea. Water are polluted with mineral waste that come from a mine. For example Sungai Air baloi in Pontian, Johor are pollute because of the industrial waste nearby(TheRocket.com,September 26, 2014) or Sungai Telang in Pahang that are causes of mineral mining nearby the river(NEWSTRAITSTIME, Gold mining to blame for pollution in Sungai Telang). The water nearby industry zone are polluted with debris, chemicals and toxic waste. This situation might endanger the ecosystem and also to human life. The polluted river also can bring disease or death to human if no action taken to solves or reduces the water pollution.

Other than that, water pollution in Malaysia is a serious threat however this the issues are ignore and taken lightly by the authorities and people. The water pollution issues will be aware by the authorities when there is a serious case such as sickness from the people that are suspected using or drinking a polluted water. An action should be taken to prevent the water pollution by monitoring the river from being pollute especially water that are nearby industrial area. In order to detect the water is going to the polluted water area and take a sample of the water sends back to laboratory to determine the parameter of the industrial waste and the result determine the condition of water is clear or polluted. Jabatan Alam Sekitar have taken an action by placing a few telemetric stations nearby industrial area that can detect water pollution such as of the Kuantan port and Gebeng industrial site.

Therefore, this project proposes a wireless water pollution monitoring system to address the stated problem. These monitoring devices will detect a water pollution at the river with a few sensors. The PH sensor is used to detects and determine the quality of the water base on the quality index of classification that determine the water are clean or polluted. Other than that, turbidity sensor will be used to measure the suspended particles in a fluid. The sensor also measures the turbidity of fresh water on the river. The other sensor is flow sensor which is to measure the current flow of the water. Arduino devices is an electronic platform that are able to read inputs such as electronic devices and turn it to output. All of those sensors will be connected to Arduino to generate input that are collected from the sensor. The wireless pollution monitoring system will be used GSM to pass the information gather from the sensor and those data retrieve will be display on a website. The user can view the current situation and condition of the water plus the system will alert the user about what action need to take if the water is polluted.

1.2 PROBLEM STATEMENT

Nowadays, with the rapid development of technology and growth of economy more and more serious of environment arises which one of the environment pollutions is water pollution. In order to detect the pollution, the authorities will have to do manually by go to the nearby river or sea to collect sample of the water and send back to the lab to determine the amount of parameter in the water and the result will determine the water are clean or polluted. This method took a long time to determine the water quality and too much man power. This problem can be addressed by providing new devices that are portable and can be placed at anywhere.

In Malaysia, the authority that conducts and monitor the environment is Jabatan Alam Sekitar(JAS). Jabatan Alam Sekitar have taken a measure to monitor the environment by place a Telemetric station at certain places such as in Kuantan port and industrial zone in Gebeng. This station will monitor and send information about the water quality to Jabatan Alam Sekitar. The drawback of the telemetric station is that it is costly to maintain and it only places at a certain are like industrial area that are highly cost more environment pollution but water pollution also can come from mining waste or garbage disposal in water. Therefore, it is great to build a low cost water monitoring system and can be placed nearby industrial zone, mining sites or river nearby village that uses river water as daily life basis.

1.3 OBJECTIVE

The objectives of this project are :

1. To study the required parameter of the water properties in order to determine the water quality
2. To design a water pollution monitoring system with a database and the system give further action for user based on the water condition result.
3. To build a low-cost wireless water quality monitoring sensor.

1.4 SCOPE

I. Staff

- The staff of Jabatan Alam Sekitar that are task to monitor the water quality.
- Staff obtain the information recorded by the system about the quality of the water.

II Admin

- Manage the Database

1.5 REPORT ORGANIZATION

This thesis consists of five (5) chapters which the part are chapter1 introduction, chapter 2 literature review, chapter 3 methodology, chapter 4 implementation, testing and result discussion and last but not least chapter 5 conclusion.

In the chapter 1 discusses on the general information about the project are stated. It is included introduction, problem statement, objective, scope, significant and report organization. Chapter 2 discusses on literature review. The discussion is about the current systems and comparison between four existing systems for analysis. It will cover about the system flow and technique used. Chapter 3 explain methodology used in the system. It comprises the theoretical analysis of the body, methods and principle of the body, methods and principle related with branch of the knowledge. Next, chapter 4 discusses about implementation this project by follow the selected methodology, the testing implemented to test the developed project and also the result after testing have been done. Lastly, chapter 5 is about the conclusion for the development process that have been done.

CHAPTER 2

LITERITURE REVIEW

2.1 INTRODUCTION

This chapter discusses on existing literature related with the proposed project. The main purpose of this chapter is to find the gaps in the existing work and for improvement of the proposed project. The review focuses on how to use the system effectively that related in the system. It will help me to get ideas and it became the researcher basis on how to start the document to analyse the current water pollution monitoring system.

2.2 EXISTING SYSTEM

The Staff of Jabatan Alam Sekitar(JAS) will have to go to the polluted water and take a few sample of the water. Then they will bring back the sample to laboratory to study the parameter in the water that cause the water to be polluted.This method is very tiresome, increase work load and waste times for the staff of Jabatan Alam Sekitar to monitor the water.The purpose of this proposed system is develop a wireless water pollution monitoring system that can be used by the staff of Jabatan Alam Sekitar. The aim of this project is to help the staff of JAS to monitor the water more efficiently and lessen work for collecting water sample.

2.2.1 Xylem Water Quality Monitoring System

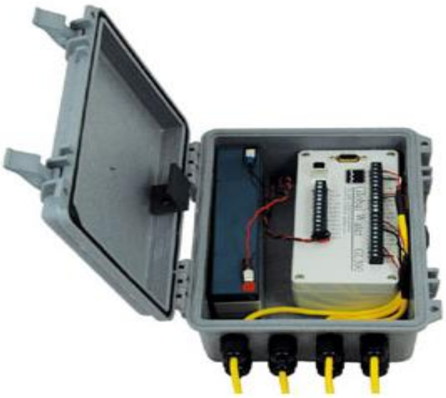


Figure 2.1:XYLEM Water quality monitoring devices.

Figure 2.1 above shows Xylem Water Quality Monitoring System. This system is a devices that monitor numerous water quality parameters with a completely incorporated, prudent and simple to work. This devices system uses temperature sensor, PH sensor, conductivity sensor and DO sensor. The temperature sensor allow the devices to check the temperature of the water, while the PH sensor to calculate and determine the value of the parameter in the water. The conductivity sensor to monitor the amount of nutrients, salts or impurities in the water and the DO sensor stand for dissolve oxygen refers to the level of free, non-compound oxygen present in water or other liquids It is a standout amongst the most critical parameters while evaluating water quality on account of its impact on the life forms living inside a waterway. This system also included multichannel data logger featuring 7 analog channels and 2 digital channels for data recording and PDA software make accessing stored data easy. In addition, this system can be add remote capabilities which use GL500-Mod Modem Package for telephone modem communications. Table 2,1 shows Advantages and disadvantages of the system.

Table 2.1: Advantages and disadvantages of XYLEM Water quality monitoring

Advantages	**Disadvantages**
Battery powered for remote locations. User-friendly WindowsTM and WindowsTM CE-based PDA software included. Portable Devices.	No datacentre. No mobile apps. Remote capability only available if added to the system

2.2.2 Smart Water System Using Wireless Sensor Network at Home/Office

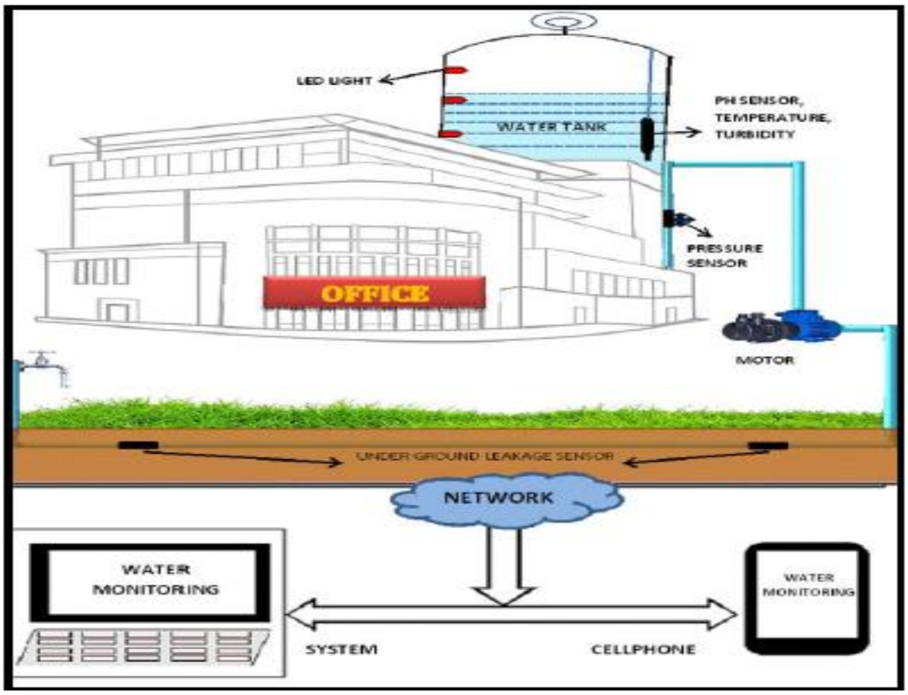


Figure 2.2: Smart water monitoring system architecture

Figure 2.2 above shows the architecture of Smart water monitoring system. This system were configuration to screen the nature of water with the assistance of data detected by the sensors drenched in water were configuration to screen the nature of water with the assistance of data detected by the sensors drenched in water, This system utilized a wireless sensor network to help the system to pass the retrieve data from the sensor to monitoring devices and to mobile devices. This system have three main function which is to monitoring tank water level to detect water overflowing and intimate level of water in the tank. Water controlling system implementation makes potential significance in home applications. Other than that, its to monitor the pollution occur in the water tank. This help the system to detect, to recognize, release of poisonous chemicals and tainting in water. To check the water quality the framework utilized Ph sensor, Turbidity sensor and temperature sensor which are typically parameter gathered in stream and lake to decide the water quality. The third function is to pipes leakages detection by using a Pressure sensor is used to recognize the leakage pipes. On the off chance that the funnels burst it will showed to the specialist and the underground sensor utilized a FSR strategy utilized for weight estimations in the proposed UWSN for pipeline checking.All this three main function sensor are connected to a wireless sensor network and send report to the system through the network. Smart Water monitoring system used MATLAB tool to monitor the system. MPLAB and MPLAB X support project management, code editing, debugging and programming of Microchip 8-bit, 16-bit and 32-bit PIC microcontrollers. This software provides a development environment for embedded microcontroller design. Figure 2.3 show the architecture of the system to understand how the system work. Table 2.2 shows the advantages and disadvantages of the system.

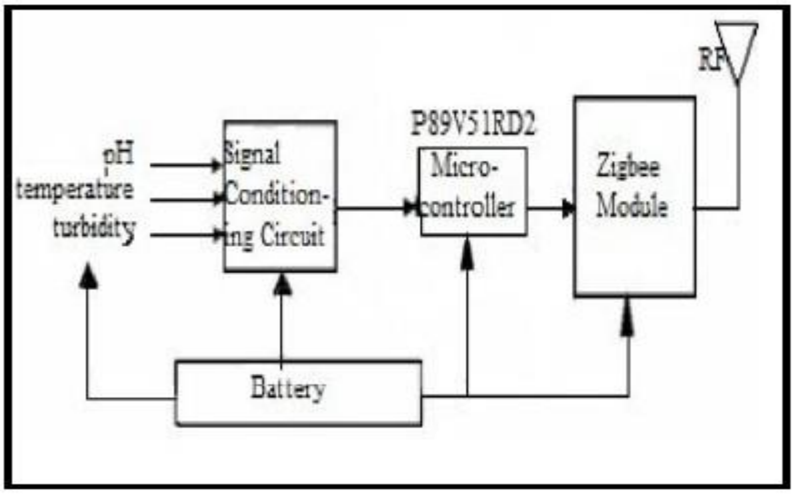


Figure 2.3: The Architecture of the system

Table 2.2: Advantages and disadvantages of Smart Water Monitoring System

Advantages	Disadvantages
• Used MATLAB tool to monitor the system • Have mobile phone as device to view data. • Multiple monitoring function	• Hard to maintain • Expensive system

2.2.3 SmartCoast Wireless Sensor Network for Water Quality Monitoring

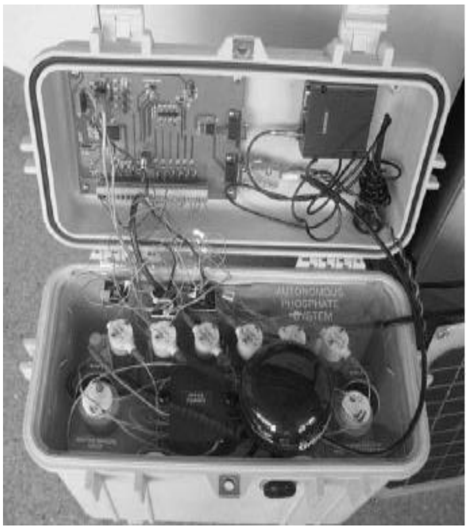


Figure 2.4**:** SmartCoast Wireless Sensor Devices.

SmartCoast in Figure 2.4 above was develop with wireless network sensor and featuring plug and play sensor platforms novel sensors and low power utilization interchanges. The WSN sending will empower and physical estimations and enable information to be seen progressively by means of the web by remote clients. SmartCoast system implemented Zigbee wireless sensor network in order to meet a low power consumption. The zigbee is incorporate with Transducer Electronic datasheet that enables a sensor to recognize and portray itself to the control unit inside the transceiver system.

This TED are based on IEEE 1451 standard. TEDS enabled sensors can be interfaced with the system in a “Plug and Play” This system implement PH, temperature, conductivity, depth and turbidity sensor. Phosphate & dissolved oxygen sensor can be added in the system with a few customize. The table 2.3 below shows the advantages and disadvantages of the SmartCoast system.

Table 2.3: Advantages and disadvantages of SmartCoast

Advantages	**Disadvantages**
Portable Devices	No datacentre
Low cost design and easy to implement	No mobile apps
Can be interface with plug and play	Not user friendly

2.2.4 Fondriest Stream and River Monitoring

Figure 2.5: Fondriest Monitoring System Devices

Figure 2.5 above shows the Fondriest Monitoring System Devices. This system is to monitor the stream and river in united states to keeping up and extending existing supplies of freshwater and to stay aware of developing interest. The request is energized by different employments such as domestic, industrial, irrigation and mining. Not all uses may draw specifically from the stream however the water required for each will have more likely than not went through the stream. This system is integrated with data logging system for real time monitoring station that house the data logger, telemetry module and power supply. A solar panel also be implemented to continuously charge the 12vdc baterry for autonomous operation. This system used PT-500 which is Submersible Pressure Transducer from APG is sufficiently tough to gauge profundity in the dirtiest, most turbulent waters. Additionally this system furnish with YSI's EXO2 Multi-Parameter Water Quality Sonde that give six sensor to checking the water quality. The sensor are temperature/conductivity, pH, DO, total algae, and turbidity sensors. The The NexSens 3100-MAST Wireless Telemetry System go about as an information logging system with cell telemetry and sun powered energizing to keep information to date. NexSens WQData LIVE Web Datacenter is an electronic datacenter that enable client to get to information gathered from telemetry. Figure 2.6 shows image of Fondriest Devices and Table 2.4 below show its advantages and disadvantages.

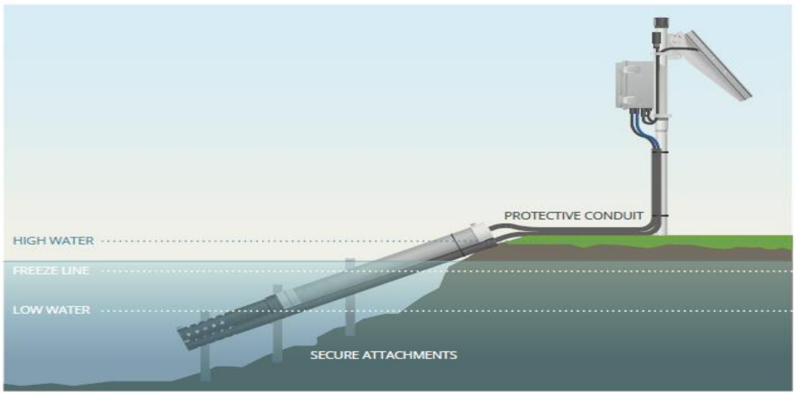


Figure 2.6: The Full Image of Fondriest Devices

Table 2.4: Advantages and disadvantages of Fondriest Monitoring System

Advantages	**Disadvantages**
Available Datacenter in web based Datacenter also can be access via mobile devices	Expensive system Hard to maintain

Can be install in remote location	

2.3 Summary Comparison of The Existing System

Table 2.5 show the summaries of the existing systems and the proposed system. The comparison againts the proposed project can help us to know a deficiency of the existiong system so that we can avoid it and become more competitive. This comparison also help to improve productivity and quality of the water pollution monitoring system.

Table 2.5: Comparison of four existing system

System /Features	XYLEM Water Monitoring System	Smart Water Monitoring System	SmartCoast Water Monitoring System	Fondriest Stream and River Monitoring	Wireless Water Pollution Monitoring System
Function	Monitor multiple water quality parameters with a fully integrated sensor	To monitor the quality of water with the help of information sensed by the sensors immersed in water	To help monitor water and manage water quality	To monitor the stream and river in united state in order to maintaining supplies of freshwater	To monitor the quality of the water with the integrated sensors.
Sensor	Temperature, PH, conductivity and DO sensor.	PH, Turbidity and temperature sensor	PH, temperature, conductivity, depth and turbidity sensor	Temperature, conductivity, pH, DO, total algae, and turbidity.	PH, Turbidity and Flow Sensors.
Wireless Type	Not stated	GSM	zigbee	Not Stated	Wifi Module
Database	Not stated	Not stated	Not stated	Yes	Yes

Mobile Application	Yes if remote access are install	Yes	No	Yes	Yes
Software	WindowsTM and WindowsTM CE-based	MPLAB and MPLAB X	Not stated	Not stated	Arduino IDE
Platform	Not stated	Mobile	Not stated	Web and Mobile	Mobile
System give information for further action by user.	No	No	No	No	Yes

2.4 Tools

Tools is the important part in developing the new system. The good functionality of tools that have been used will creating the quality of the system. So, before developing the new system, developer need to understand about what tools that available and suitable to use.

2.4.1 Sensor Devices

Sensor is a devices to identify and react from the contribution of physical condition. The particular information could be light, warm, movement, dampness, weight, or any of an awesome number of other ecological phenomena. The output of the sensor is fundamentally a signal that changed over information or yield in comprehensible show at the sensor area or transmitted electronically finished a system for perusing or further handling. Sensor devices are important in monitoring water pollution because the sensor have to detect the pollution in the environment.

2.4.1.1 PH Sensor

PH is a instrument to measure the hydrogen-ion activity in water-based solutions, The PH is something referred to as a "potentiometric pH meter”. In water pollution monitoring system, the sensor calculates the value of the pollution to determine the level of water quality based on the PH meter. It is generally expressed with a numeric scale ranging from 0-14. The value 7 represents neutrality. The numbers on the scale increase with increasing alkalinity, while the numbers on the scale decrease with increasing acidity. Each unit of change represents a tenfold change in acidity or alkalinity.

2.4.1.2 Turbidity Sensor

Turbidity is a reduction of transparency of a liquid caused the nearness of dissolved suspended matter. Turbidity is the darkness or dimness of a liquid caused by vast quantities of individual particles, like smoke in air. The estimation of turbidity is a key trial of water quality. Territories inclined to high bank disintegration rates and in addition urbanized zones contribute a lot of turbidity to nearby waters, many drinking water utilities strive to achieve levels as low as 0.1 NTU. The European standards for turbidity state that it must be no more than 4 NTU. The turbidity is represented by the output voltage of the output pin. Clear water with NTU 0.5 is give voltages 4.21v. While NTU 50 is 4.10v and NTU 500 is voltage of 3.27.

2.4.1.3 Water Flow Sensor

A device used to measure the flow rate or quantity of a gas or liquid moving through a river. Flow measurement are very exceptionally assorted and every circumstance has its own limitations and building prerequisites. Flow sensor also provide accurate monitoring and flow control of the water. The flow sensor reading for normal is below 1.57mm. For low tide reading is below 6.50mm and for high tide reading is higher than 10mm.

2.4.2 Wireless Sensor Network

Wireless sensor network is a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. WSNs is used to gauge ecological conditions and monitoring such as air, water, temperature, sound and pollution level. These sensors depend on remote conectivity and unconstrained development of systems for the sensor information to can be transport remotely. Wireless Sensor Network are crucial for water monitoring pollution because it involves in analyze the water properties in river, sea or lake. The use of many wireless distributed sensors enables the creation of accurate map of the water status and allows the deployment of monitoring stations in locations targeted.

2.5 Wireless Network Technology

Wireless networks are computer networks that are not connected by cables of any kind. The use of a wireless network enables enterprises to avoid the costly process of introducing cables into buildings or as a connection between different equipment locations. The basis of wireless systems are radio waves, an implementation that takes place at the physical level of network structure. In this topic will discuss the few type of wireless network technology and comparison that are show in table 2.6 below.

2.5.1 ZigBee

Zigbee is an open global standard that is designed specifically to be used in M2m network. This technology required less power to operate and have a low latency that allowing product to maximize battery life. The ZigBee able to connect multiple devices together simultaneously where user may. The ZigBee coverages is 50 m and the speed is up to 250 kbps.

2.5.2 Wifi

Uses radio wave for connectivity that allow two devices to communicate with other devices. Most commonly used to connect internet router but also can be used to connect together with any two hardware component. Wifi utilize the 2.4GHz and 5GHz for frequency. The wifi speed can reach up to 150mbps and coverages around 200m. Wifi can be implement in monitoring environmet such as pollution, temperature and so on.

2.5.3 WiMax

Stands for Worldwide interoperability for microwave Access. WiMax allow data to be transferred at a rate of 30-40 megabit per second. This wireless technology provides internet services for longer distances than standard Wi-Fi. WiMax used fixxed and mobile station to provide access to high speed data and internet connectivity. WiMax coverange is longer than standard wifi with the range of 5-100 km and is good to be placed in remote location. Also the WiMax used 2-11 Ghz and 10-66 GHZ frequency.

2.5.4 GSM

(Global System for Mobile communication) is a mobile telephony system uses to digitizes and compresses data, and send it to a channel with other stream of user data. The GSM operates at either 900 MHz or 1800Mhz frequency band. GSM also one of the widely used wireless telephony technology. The range of GSM is 10km and with the speed of 9.6 Kbps. Although GSM is based on the time division multiple access. This technology uses digital signalling and speech channels and considered as a second generation (2G) mobile phone system.

2.5.5 Comparison Between Wireless Network Technology

Table 2.6:Comparison Between Wireless Network Technology

Technology	**Coverage**	**Speed**	**Frequency**	**Advantages**	**Disadvatages**
ZigBee	50 m	20/40/250 Kbps	2.4 Ghz	Low cost,Low power consumption.	Does not penetrate buildings well, low speed
Wifi	200 m	Up to 150 Mbps	2.4 Ghz	High speed, wide distribution.	High power consumption,
GSM	10 km	9.6 Kbps	900 – 1800 Ghz	2-factor authentication, support for roaming.	Needs special processing to handle handoffs, Low speed
WiMax	5-100 km	80 Mbps	2-11 Ghz	secure and reliable, high speed and coverage.	Limited access to spectrum,

2.6 Database

Database is the collection of information that has been organized to easily accessed, managed and updated. It is important part in the system that can store the sensitive information of the system.

2.6.1 MySQL

MySQL is an open source database based on Structured Query Language (SQL). MySQL is the popular database system that used with the PHP programming language. MySQL is the database system that used on the web page or website and it runs on a server. MySQL is easy to use, fast and also can use in small and large application.

2.6.2 Oracle Database

Oracle database is collection of data treated as a unit. Oracle is store and retrieved the information. Oracle is the database for Java language.

2.6.3 Comparison Between Database System

Table 2.7: Comparison Between Database System

FEATURES	MySQL	Oracle Database
Operating System	Windows Unix Linux	Windows Unix Linux
Maximum Size	Unlimited	Unlimited
Language Implement	C, C++, PHP	C, C++
Type of System	Static	Dynamic and Static

2.7 SUMMARY

From three existing system that compared in the Literature Review, Wireless water monitoring system will be using PH, turbidity and flow sensor for the monitoring the water pollution. The water pollution system also will be equip with wireless sensor for trasportation of data to mobile application. This system will be used Wifi wireless network technology. Other than that, a database will be design to stored the data obtain from the sensor and a mobile application platform will be developed for user to view the data or information about the water quality and a notice will inform the user for further action if the system detects a pollution. MySQL Server is the best database for the water pollution monitoring system. The best software to developed the mobile application is android studio because it help to build the highest-quality apps for every Android device and provide a tool custom-tailored to develop application.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will discuss the methodology that be implemented for the development of this project. This chapter also discusses overall workflow of the Water monitoring system. This chapter covers also the explanation of chosen methodology that is suitable for the project, project method, tool use to develop the system and the diagram to show the architecture of the system. Methodology is a systematic framework that utilization to structure, plan and control the way toward building up a system. The selected methodology can guide to complete the project starting from the beginning until the project is complete. There are many type of methodology with different technique and criteria that could help the development of the system and developing the cycle to achieve a better result. For this project, Waterfall methodology will be implemented.

3.2 METHODOLOGY

3.2.1 Justification of Chosen Methodology

The methodology that will be implemented to this project is Waterfall methodology. Waterfall methodology model is chosen for this project because this methodology is a simple and easy to understand and use. In waterfall model, the development of one phase starts only when the previous phase is complete. Furthermore, each phase of waterfall model is quite price well defined. The Waterfall methodology phase include the following as show below.

I. Requirement analysis phase
II. Design phase
III. Implementation phase
IV. Testing phase
V. Deployment phase
VI. Maintenance phase

These six phases in the waterfall methodology should be followed step by step to make sure that the project will be developed be more systematic and achieve a highest quality of product. Waterfall also be chosen to develop this project because this type of methodology allows to conduct one phase at one time. Thus, this makes it easy to maintain. Other than that, the entry and end criteria in waterfall are well defined. Apart from that, it easy and systematic to proceed with quality. Figure 3.1 shows the diagram of the Waterfall methodology phase that is follow and implemented.

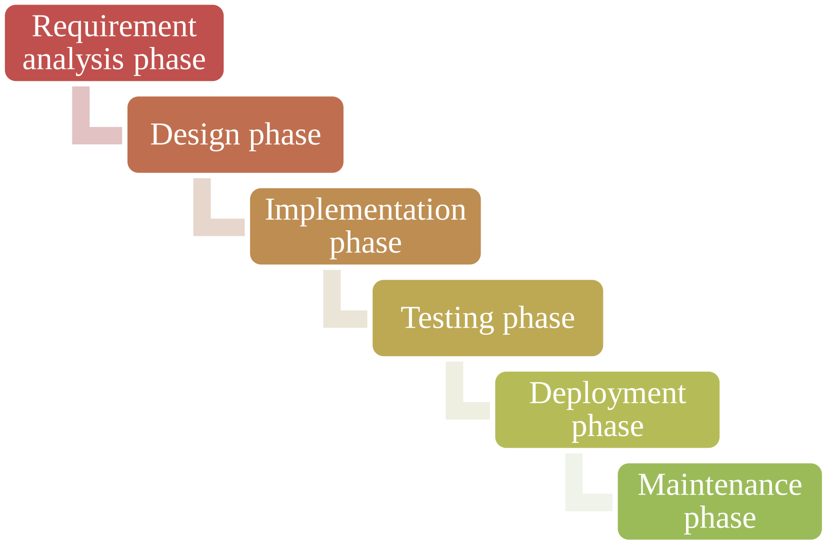


Figure 3.1: The Waterfall Model.

I. Requirement analysis phase

In requirement analysis, we have to decide what we want to do and the problem that are trying to be solve. The problem of using manual technique to monitor the water pollution by taking sample of the water and bring to lab to determine the water are polluted or not. Thus a wireless water pollution monitoring are propose that an help to solve the problem. Then defining the objective and scope of water monitoring pollution system. Moreover, a Gantt chart must be prepare to schedule and plan all the activities that involved during the project development together with the duration of each activities. Then the system is defined in detail. In this phase, we are gathering the functional requirement that can be include in the system to ensure that the system can provide a better way for the authority to monitor the water from pollution. In addition, a obtaining the information and specific data related to the existing system. Other than that, analysis on the ability and function provided by the existing system related to water pollution monitoring system are done to solve the problem using manual technique. This can help to understand and determine the weakness and strength of the existing system in order for us to create a better system.

II. Design phase

The design phase focus on the system design on the related data along with the information that have been collected during the requirement analysis stage. The design architecture of the wireless water pollution monitoring system based on the requirement specification to ensure that we can see the overview of the system in details. This phase also focus on the design function and operation are describe in detail including the system process, screen layout, function of the hardware and other documentation. In this phase function of each hardware and the system must be identify, the data that have been collect by the sensor, the connection between devices such as sensors and the mobile phone as a place to show output, the flow of the process an data dictionary in the database.

III. Implementation phase

When the requirement specification and design phase is completed, the next phase in Waterfall is implementation phase. This phase is where the coding is been develop according to the system design documentation in the previous phase. The implementation process is divide in modules or units to ensure that it can easy to develop and testing in the next phase. In this development water pollution monitoring system is separate into two which is the coding in the Arduino and sensors and for website development and the database. The mobile application is using the Android Studio Software to create an application that can allow the user to check the condition of water in different location and also will be given a decision about the action need to take if pollution occurs. For the Arduino devices code will be used a Arduino IDE software designated only for arduino devices and are used for the arduino to detect the input collected by the sensors. Next will be the development of the database using Xampp.

IV. Testing phase

Testing phase is important in the Waterfall methodology. A testing must be conducted before the system is going to be deploy. After the development of code in the system, the system will be tested to ensure that the water pollution monitoring system is actually working and solved the needs addressed. Also, the system solve the issue needed during the requirement phase. In the testing phase, all type of test are done such as hardware testing and system testing. Testing process from small unit in Water Pollution monitoring system must be done to make sure all the function and operation can be run smoothly without error. The aim of testing is to find any defect in the system as well as verifying and validating whether the development of the system is meet what has been documented in requirement analysis phase. Then, the defect that found during testing will be fix. When all error is fix the system can be deployed.

V. Deployment phase

After done testing phase and the application is free of error, we can proceed with the deployment phase. In deployment phase, the water pollution monitoring system will be deployed on a river to monitor the condition of water at the river. The mobile application of the system is used by the staff of Jabatan Alam Sekitar to monitoring the river and the application will give a discussion for the staff to take action if pollution occur. The database will stored the data taken from the system and use for the future analysis.

VI. Maintenance phase

Maintenance phase is the last phase in Waterfall model, this phase is conduct when there are some issues occur in the client environment, for example, one of the sensors are broken and cannot function properly or the power supply cannot be used. When this issue occurs, the developer need to identify the problem and start fixing it. After that, the sensors that fixed will be test again to ensure that the application can run smoothly and the code are free from error. When maintenance is done, the system will deliver to the client environment.

3.2.2 Context Diagram

The context diagram is an organized graphical tool utilized for distinguishing the useful areas and the procedure which are performed inside and between the system. Setting chart bolsters an information arranged approach for outlining system. Context diagram supports a data-oriented approach for designing system. It additionally characterizes the limits of the proposed system. The symbol utilized as a part of the setting graph are outside elements, information stockpiles and information stream and process. The figure 3.2 show a context diagram represent the water pollution monitoring system, which have a staff and Admin. The Staff required to enter username and password in order to access the mobile the system via mobile application. The staff can view the condition of water and action needed to prevent water pollution. The Admin only manage the database.

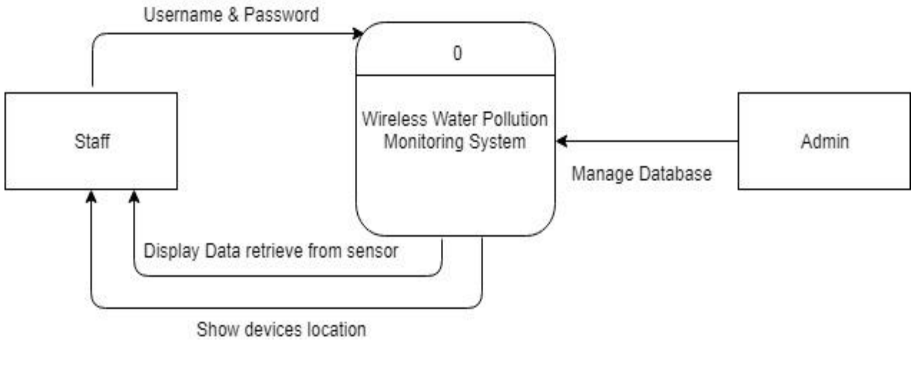


Figure 3.2 Context Diagram of The System

3.2.3 Use Case Diagram of Wireless Water Pollution Monitoring System

Use case diagram is one of the diagrams listed under Unified Modeling Language (UML) that depict the interaction between the user and system. Some of the activities in the system require the involvement of both user and the data updated by the user will be recorded sequentially into system. Wireless Water pollution monitoring system consist of function that determine the purpose of the system. The actor of the system is. Refer Figure 3.3 for overall illustration on system functionality and the involvement of user into the system.

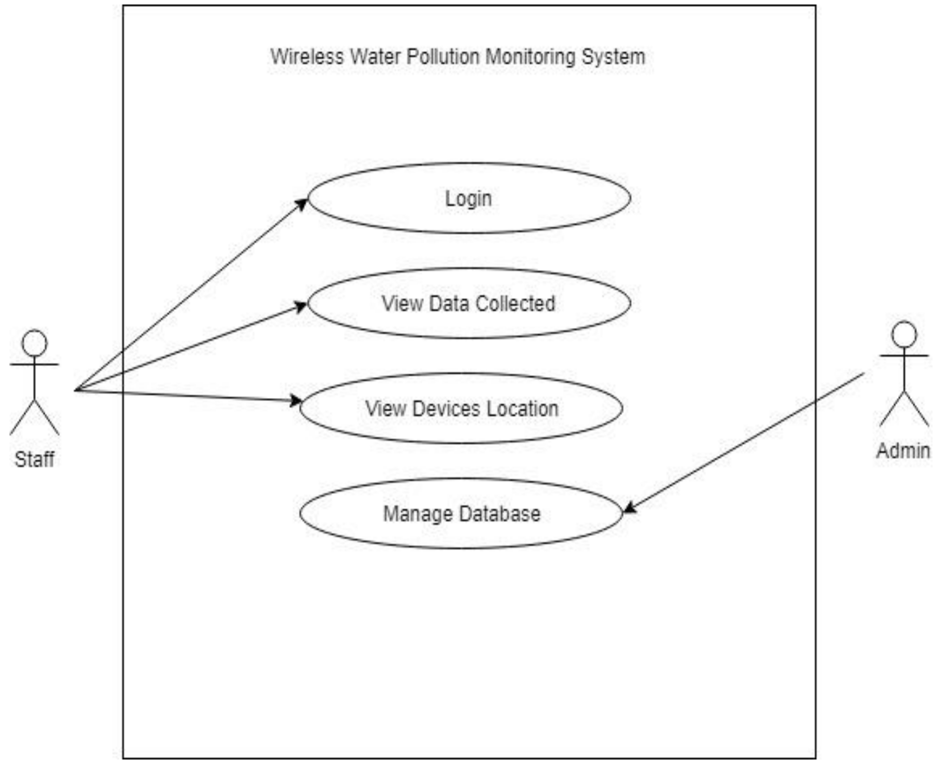


Figure 3.3: Use Case Diagram of The System

3.2.4 Modules

i. Module 1: Login Module

This Module requires the user of Wireless Water Pollution Monitoring System to login to use the system. The system will verify user if the user login is staff . The user needs to provide email and password to login.

ii. Module 2: View Water Condition Result

This module is designed for the staff of the system. This module enable staff to view the quality and the condition of the water and also show the action needed by the staff for monitoring the water such as river.

3.2.5 Dialog Diagram

Dialogue diagrams are used to visually map the steps in the user tasks. Like the user tasks, the focus is on the user interaction with the system. By drawing the steps involved in the interaction, actions that may have been missed out are discovered. Refer Figure 3.4 shows the steps when using the WWPMS.

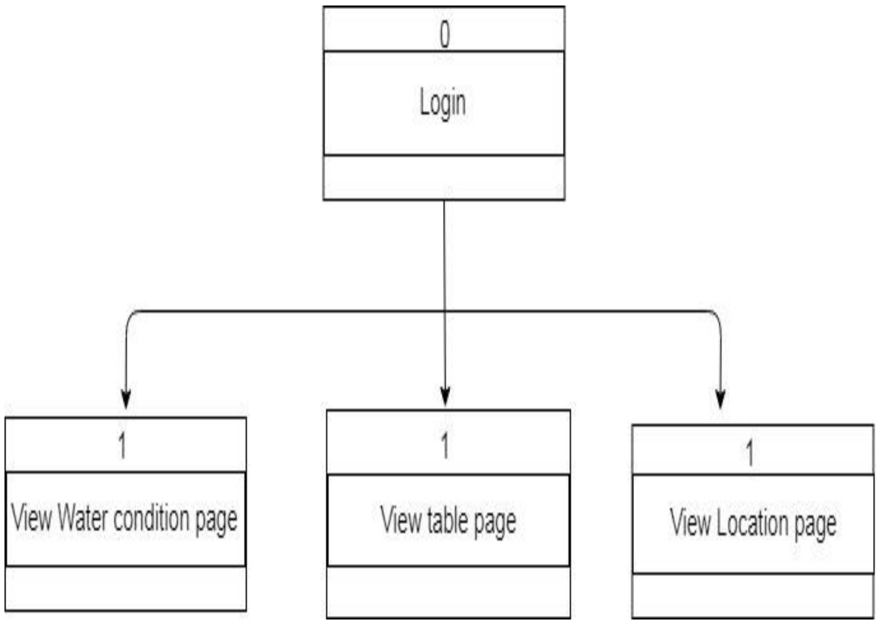


Figure 3.4: Dialog Diagram

3.2.6 Flowchart

A flowchart diagram is a type of diagram that shows a algorithm and workflow of the system. It also represents the boxes as entity and connecting them in order using an arrow.

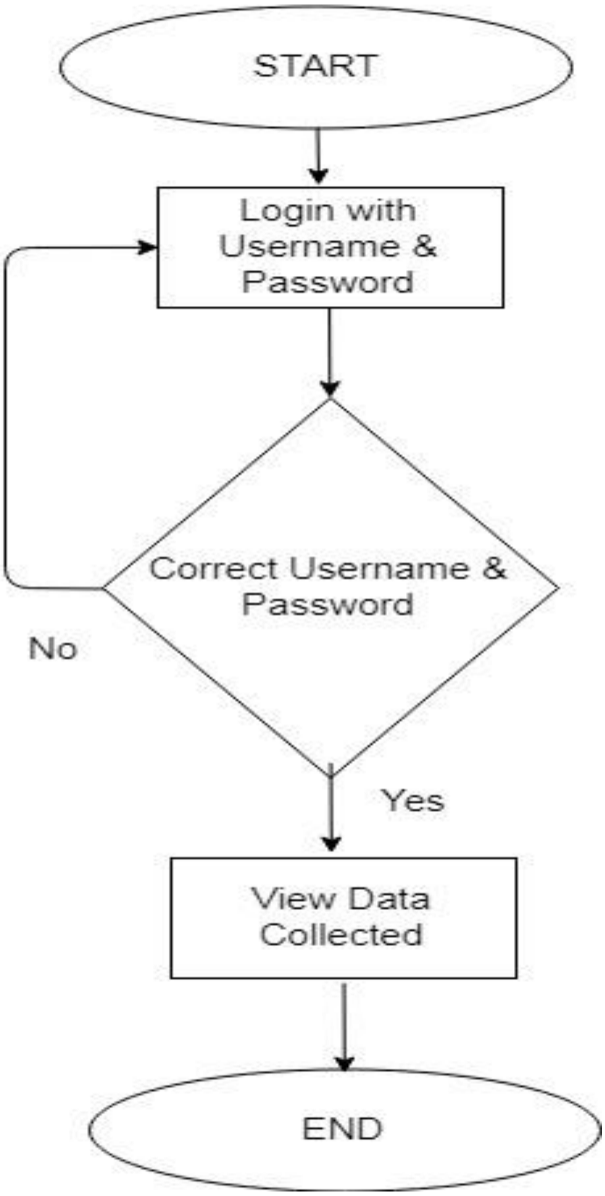


Figure 3.5: Flow Chart of WWPMS

3.2.6 User Interface of Wireless Water Monitoring Pollution

A. Figure 3.6 shows Login page of WWPMS

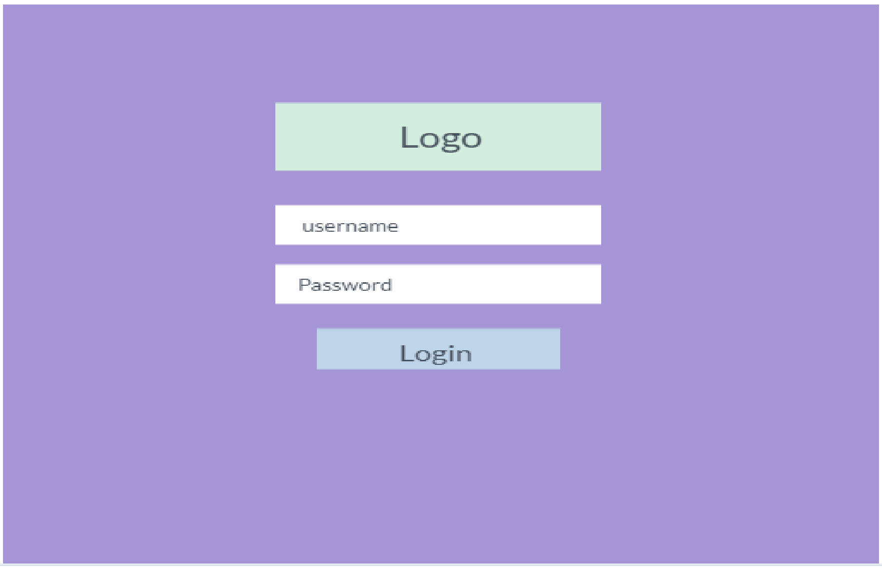


Figure 3.6: Login page on Web Application

This page shows the interface of Login. The user will enter Username and password in order to access the system.

B. Figure 3.7 shows the WWPMS Pages of WWPMS

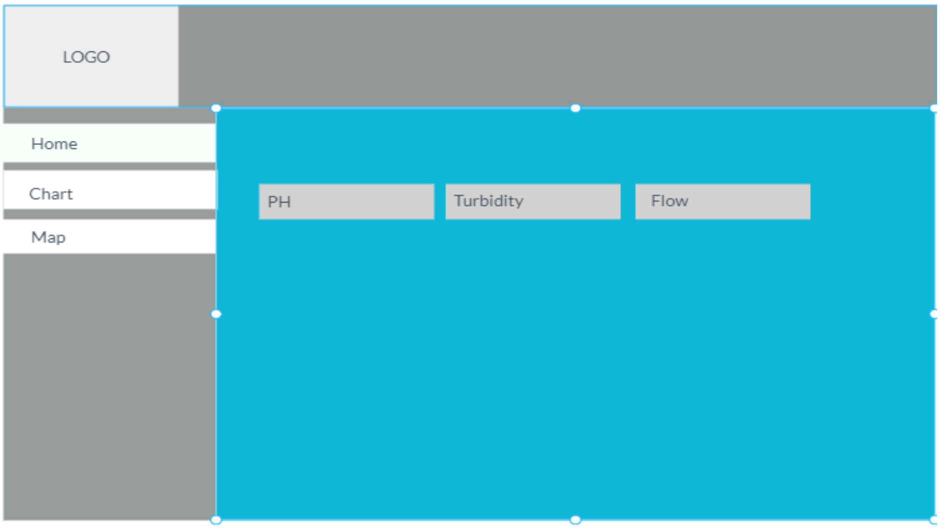


Figure 3.7: WWPMS page on Web Application

This pages show the retrieve data from the sensor. The data retrieve from the sensor will stored on the database. Then the web application will display on the home page.

C. Figure 3.8 shows Table page of WWPMS

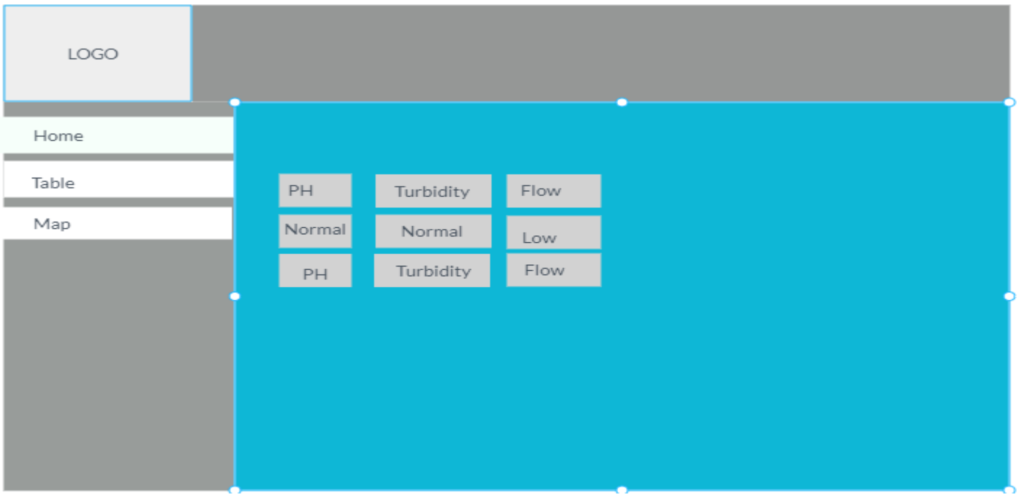


Figure 3.8 View table of monitoring on Web Application

This page show the table of monitoring. This table shows the previous data collected from the sensors.

A. Figure 3.9 shows Maps page of WWPMS

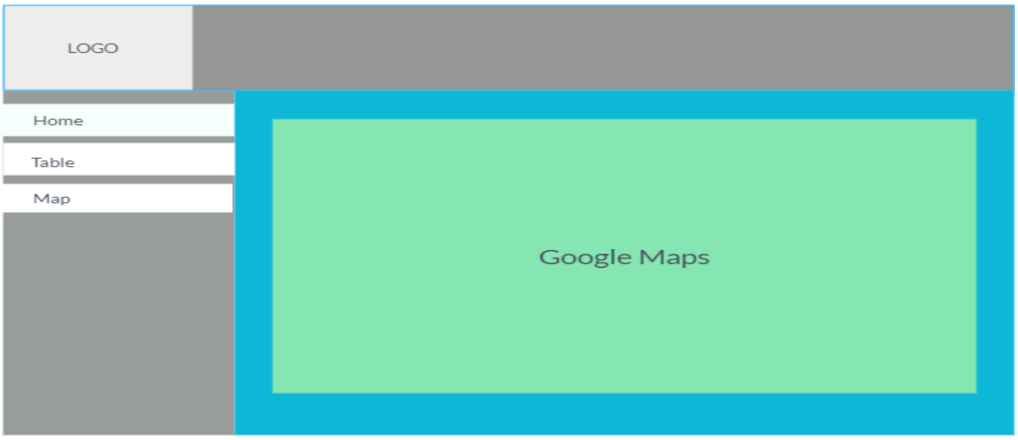


Figure 3.9: View the location of the devices

This page show the location of the device. The map will show the location of the devices.

3.2.7 System Architecture

The figure below will show how the design layout of the connection between the Web Application and the Arduino. This shows how the data are being transferred between the Web Application and Arduino. Figure 3.10 shows the architecture of the system.

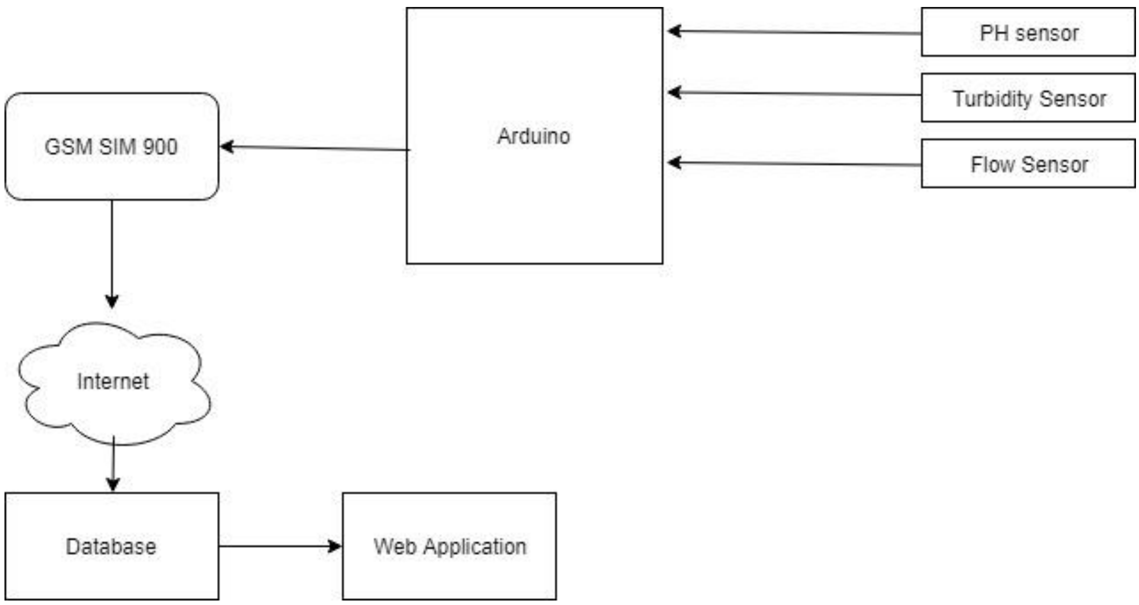


Figure 3.10: System Architecture of Wireless Water Pollution Monitoring System

1) PH Sensor

PH (potential of hydrogen) is a logarithmic scale used to specify the acidity or basicity of an aqueous solution. Solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are alkali. Pure water is neutral, being neither an acid nor a base. The table below show the reading of PH value. The table 3.1 show the reading of PH value..

Table 3.1**:** PH Value Table

PH Value	Condition
1-6	Acid
7	Neutral
8-14	Alkali

2) Turbidity Sensor

Turbidity is the measure of relative clarity of a liquid. It is an optical characteristic of water and is an expression of the amount of light that is scattered by material in the water when a light is shined through the water sample. The higher the intensity of scattered light, the higher the turbidity. The units of turbidity from a calibrated nephelometer are called Nephelometric Turbidity Units (NTU). The NTU were determine by the voltages in the water. The lower the voltages the cloudier the water. The table 3.2 show the reading of Turbidity.

Table 3.2: Turbidity Value Table

Voltage	Condition.
Above 4.20	Very clean
4.19 – 3.70	Cloudy
Less than 3.69	Very cloudy

3) Flow Sensor

Flow measurement is the quantification of bulk fluid movement. Can be measured in a variety of ways. Positive-displacement flow meters accumulate a fixed volume of fluid and then count the number of times the volume is filled to measure flow. The table 3.3 show the reading of Flow value.

Table 3.3: Flow Value Table

Flow	Condition
<1.57 mm	Normal
<6.50 mm	Low Tide
>10mm	High Tide

1) Table of Decision

A table of decision is use during the monitoring of the system. This table will display the combined result gather from PH, Turbidity and flow sensor. With the following result can determine the action need for the staff of JAS to prevent with actions. The table 3.4 show the example of the table will be implement in the system.

Table 3.4**:** Sample of Decision with action

Parameter	PH	Turbidity	Flow	Decision/ Action to be taken.
Value	3	4.10	<1.75mm	The condition of water is acidic and not safe for drinking. A notice must be made within 24 hours to prevent people from drinking the water.
Condition	Acid	Cloudy	Normal	

The table 3.5 show the result for normal reading of the system.

Table 3.5: Sample of Decision for no action

Parameter	PH	Turbidity	Flow	Decision/ Action to be taken.
Value	7	4.35	<1.75mm	No action required and keep monitoring.
Condition	Neutral	Clean	Normal	

The table 3.6 show the result when the turbidity are very cloudy and the flow reading are high which it will show what action need.

Table 3.6: Sample of Decision with action

Parameter	PH	Turbidity	Flow	Decision/ Action to be taken.
Value	7	3.65	>11mm	The level of cloudiness is high with particles . The current flow are not suitable to do monitor activity. Wait for the current flow to be normal.
Condition	Neutral	Very Cloudy	Tide Flow	

3.3 Hardware and Software

Two major requirements of a system are hardware and software. Both parts contribute to developing the software system.

3.3.1 Hardware Requirement

Table 3.7 show proposed hardware requirement for the Wireless Water Pollution Monitoring System.

Table 3.7: Hardware Requirement

Item	Minimum Requirement	Function / Purpose
Laptop	Intel Core i5 530 RAM: 4GB Storage: 500gb	The computer used for the development and documentation of the system.
Android Phone	Android Lollipop 5.1 RAM: 2gb Internal Storage: 16gb	The Android phone used for installing the system and testing tool in the mobile version of the system.

External Hard Disk	Storage: 500 GB	The external hard disk acts as a data storage for the system development file and documentation backup storage.
USB Cable	USB Micro B	USB cable is used to connect and transfer data between laptop and Android phone.
Arduino Devices	Arduino Uno R3 ATMEGA328P	Arduino board designs use a variety of microprocessors and controllers. Used as the main digital devices and interactive objects that can sense and control objects in the physical and digital.
PH Sensors	PH sensor Probe	Used to measure the value of acidic and alkali in a water. Acidic:1-6 Neutral:7 Alkali:8-14
Turbidity Sensors	Liquid water turbidity detection sensors	Used to measure the value cloudiness or haziness of a fluid caused by large numbers of individual particles. Turbidity are measure based on nephelometric turbidity units(NTU).If NTU increases, the liquid turbidity level increases. Example: Above 4.20: Clean 4.19-3.70: Cloudy Less 3.69 Very Cloudy
Flow Sensor	½ Inch 20.5mm Water flow sensor fluid.	Used to measure the flow and the pressure of the water.
GSM SIM900	WiFi Shield Module For Arduino R3	The Wifi module the act as connection between the Arduino and the Website.

Battery	Arduino 7.4v 1500mAH 18650 Li-ion Rechargeable Battery	The Main source of power to run the system.
Arduino Breadboard	Mini Solderless Breadboard Prototype	Allows to prototype Arduino project without having to permanently solder the circuit together and also allow to create temporary prototypes and experiment with different circuit designs.

3.3.2 Software Requirement

Table 3.8 show proposed software requirement for the Wireless Water Pollution Monitoring System.

Table 3.8: Software Requirement

Software	Function / Purpose
Microsoft Office 2016 Microsoft Word Microsoft PowerPoint Microsoft Visio Microsoft Project	Microsoft Word used to design the proposal and documentation of the system. Microsoft PowerPoint used for preparing a slide for presentation and Microsoft Visio used to design UML diagram and model.
Notepad++	Used as a platform to develop an Web application.
Arduino IDE	Used as a platform to develop coding in the devices.
MySql	XAMPP is used for local web server during development and testing.

3.4 Gantt Chart

Gantt chart shows the activities of the project with the timescale. The project is divided into few phases which are Planning and Analysis, Designing System, Developing System, Testing and Finalize Document. The Gantt Chart of this project can be referring in Appendix A.

3.5 Implementation

The implementation of project started with collecting requirement based on comparison of existing systems. Furthermore, we can produces a feature from current ones which lack of features and have some of disadvantages which will be improve and enhancing current feature.

Project started with drawing the flow of diagrams which are Context Diagram, Use Case, Dialogue Diagram and System Architecture. From the drawing we will know the flow and interaction of system analyzing the structure of diagrams.

The first step is installing and integrated the sensors with the Arduino Uno. During this step, a precaution need to install the sensors with Arduino because if there is mistake when installing the devices will result the devices are damage. Arduino IDE used for developing codes and function on each of the sensor. The implementation of Xampp as a tool to stored information data of the system. Notepad++ software function is to develop the Web application of water pollution monitoring system. Also the development of the interface of website according to the flow of the diagram already drawing.

For the Web application, the user need to login to use the application. The user of the system must be a staff of JAS. The user of the application will able to view the result of monitored water. The user will be show a table consist of PH value, Turbidity, Flow and Action for current monitored river. The user also can view the previous data collected from the system to do analysis on the river water.

3.6 Testing

Software testing it is important plan to check whether the actual result matches with the expected result of the system. Black-box Testing has been chosen as the testing plan for the Wireless Water Pollution Monitoring System. Black-box testing is a functional testing where the testing focuses on the output generated by the system and the execution of the system. This technique will ignore internal mechanism of the system. The proposed system will go through the functional testing to test behavior of the system. The advantage of using this technique is the contradictions of the system and the specifications can be verified.

In performance testing is intended to test the run-time execution of programming inside the setting of a coordinated system. Indeed, even at the unit level, the execution of an individual module might be surveyed as white-box tests are conducted. White Box testing will be focus on testing activity which the internal structure, design and structure which are known by tester. The diagrams which are Use Case diagram, Context diagram, Package diagram and Dialogue diagrams use as reference for the structure of development, interaction and modules with functions for implementation. After that including unit testing input and outputs and function of each module.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

The purpose of this chapter is to discuss about the process of implementation, testing and result of the project system. In order to relate with the implemented methodology, this process occurs during the implementation and testing phase. This chapter also includes the explanation of the discussion that show the objectives of this project is fulfilled. During the implementation process, all functions are code by using HTML, PHP and Bootstrap. Then, the testing phase is performed to make sure that the obtained result is complements with system analysis and design in the previous chapter. This chapter also will discuss of the constraint of the project. The system will give more clear result to planning and arrangement of the system for the future work.

4.1.1 Testing and result discussion

This subtopic discusses about the procedure taken and the specific implementation process of this project. All processes that involved in the implementation phase are recorded and also described how the project was constructed. It also includes the example of coding implemented for all function and module as discussed in previous chapter and show the user interface of Wireless Water Pollution Monitoring System.

4.1.2 DEVELOPMENT ENVIRONMENT

During the implementation phase, the first thing to be done is set up the computer with development tools such as Notepad++ that used to develop the project web application and Arduino IDE to code function in Arduino. During the process of implementation Wireless Water Pollution Monitoring System web application, all interface of this application are develop using Notepad++. It functions are code using HTML, CSS and PHP. Figure 4.1 shows the interface of Notepad++ that used to develop Wireless Water Pollution Monitoring System web application.

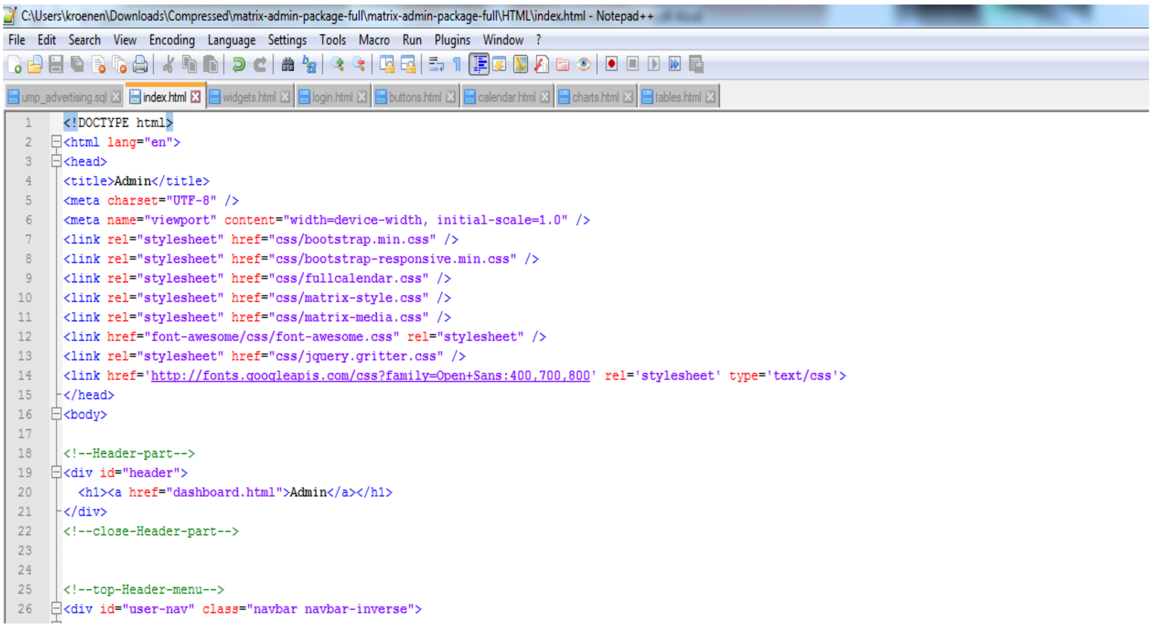


Figure 4.1 Notepad++ Interface

Next, set up and run Xampp server where used as the database to store the data of BFRA. There are many web server that can be used to store a database, but the reason that Xampp web server was chosen because it is easy to use and both development tools can support and easily create connection with it.

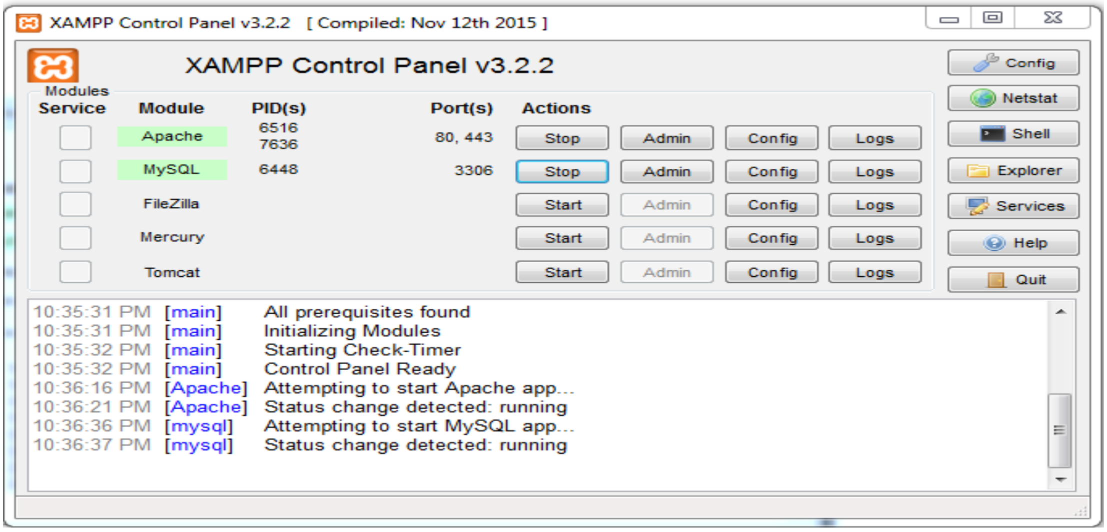


Figure 4.2 Xampp Control Panel

Figure 4.2 above shows the XAMPP control panel interface. In XAMPP control panel, Apache module and MySQL module must be enabled before run the application to ensure that Wireless Water Pollution Monitoring System can connect with the database. Database is the important part of this application because the data for web application are stored. Therefore, the configuration of database must be configured correctly to avoid unexpected problem. PhpMyAdmin is the platform that used to created database in XAMPP web server.

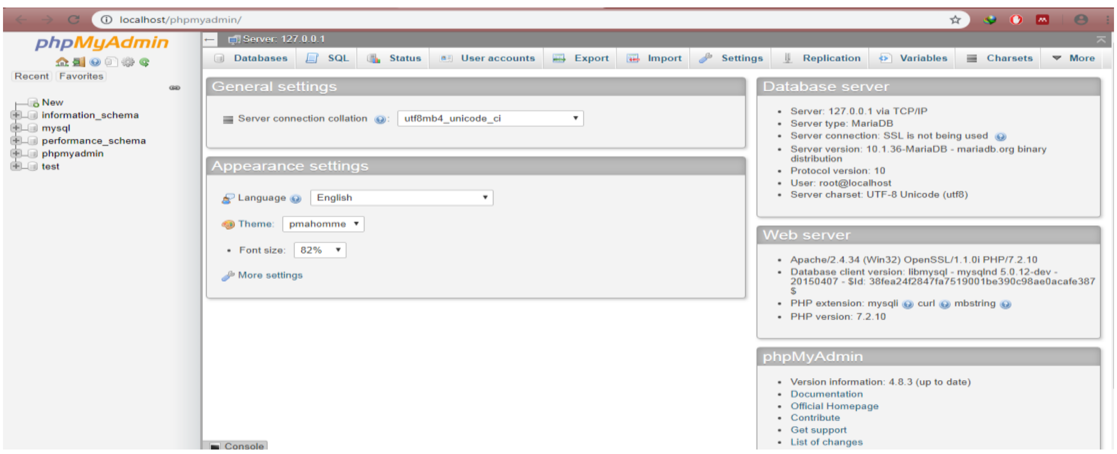


Figure 4.3 PhpMyAdmin Interface

Figure 4.3 shows the interface of PhpMyAdmin which is the platform that use to create the database for this project.

The Arduino Uno can be programmed with the Arduino Software(IDE). The Arduino Software (IDE) make it easy to write code and upload to the Board. The Arduino Software (IDE) uses C/C++ language to write code. This software are important to write function code in the sensor for Wireless Water Pollution Monitoring System. Figure 4.4 and Figure 4.5 shows the interface of Arduino Software (IDE)

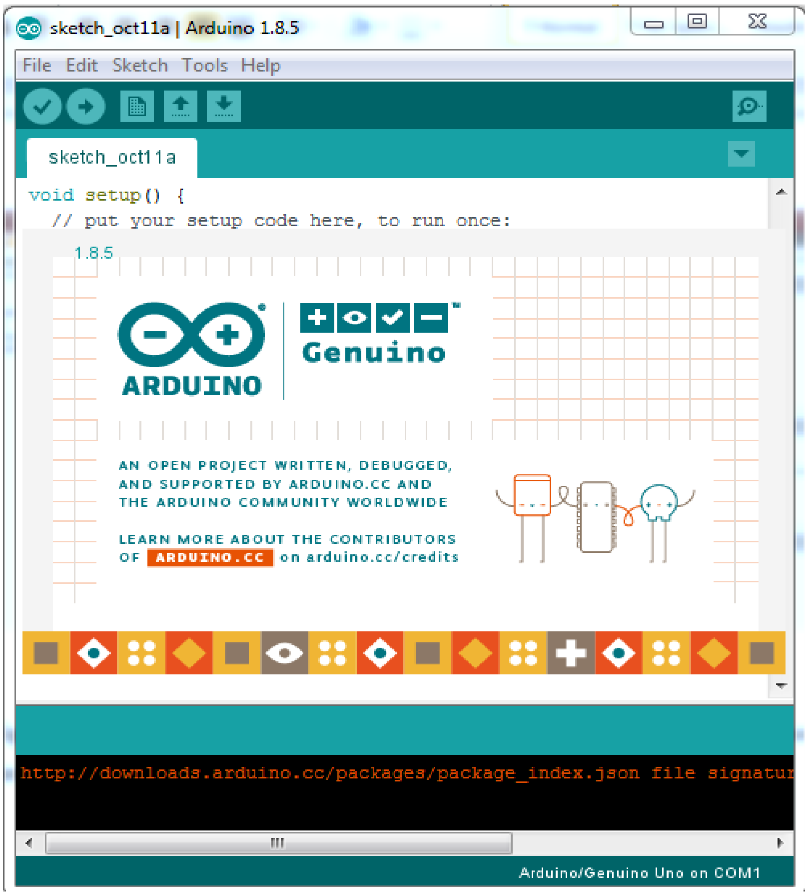


Figure 4.4 Arduino Software (IDE) Interface

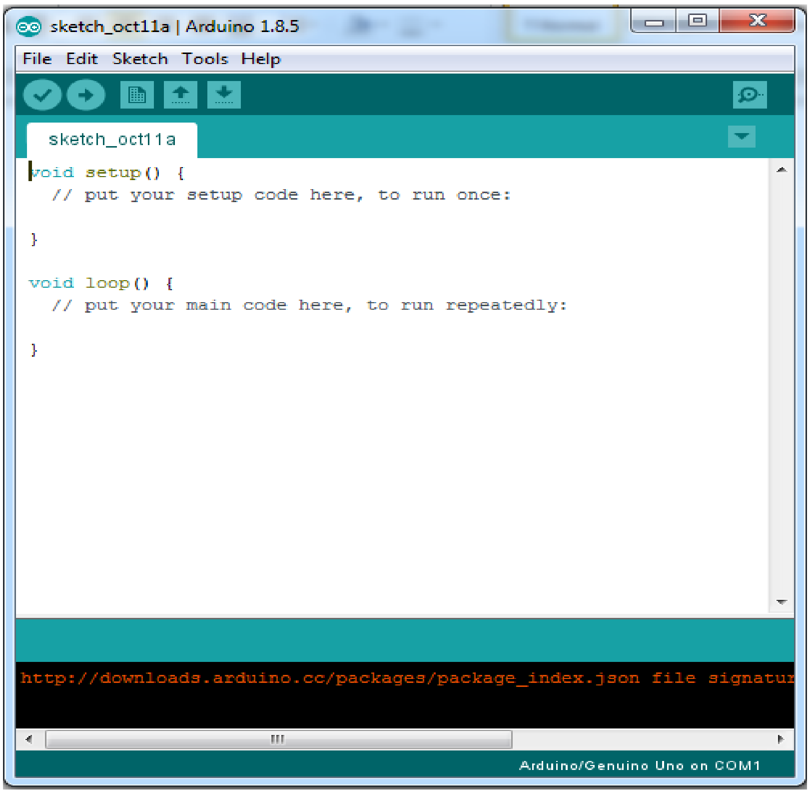


Figure 4.5 Arduino Software (IDE) Interface

4.2 USER MANUAL

User manual is a technical communication document intended that help people or users using a Wireless Water Pollution Monitoring System. The user manual will show the flow of the system with the details explanation.

4.2.1 Web Application System

The web application system is designed for the staff of Jabatan Alam Sekitar to view the data collected from the sensor devices. This Web application will the retrieve data from sensor, view table information and view map for the location devices.

LOGIN PAGE

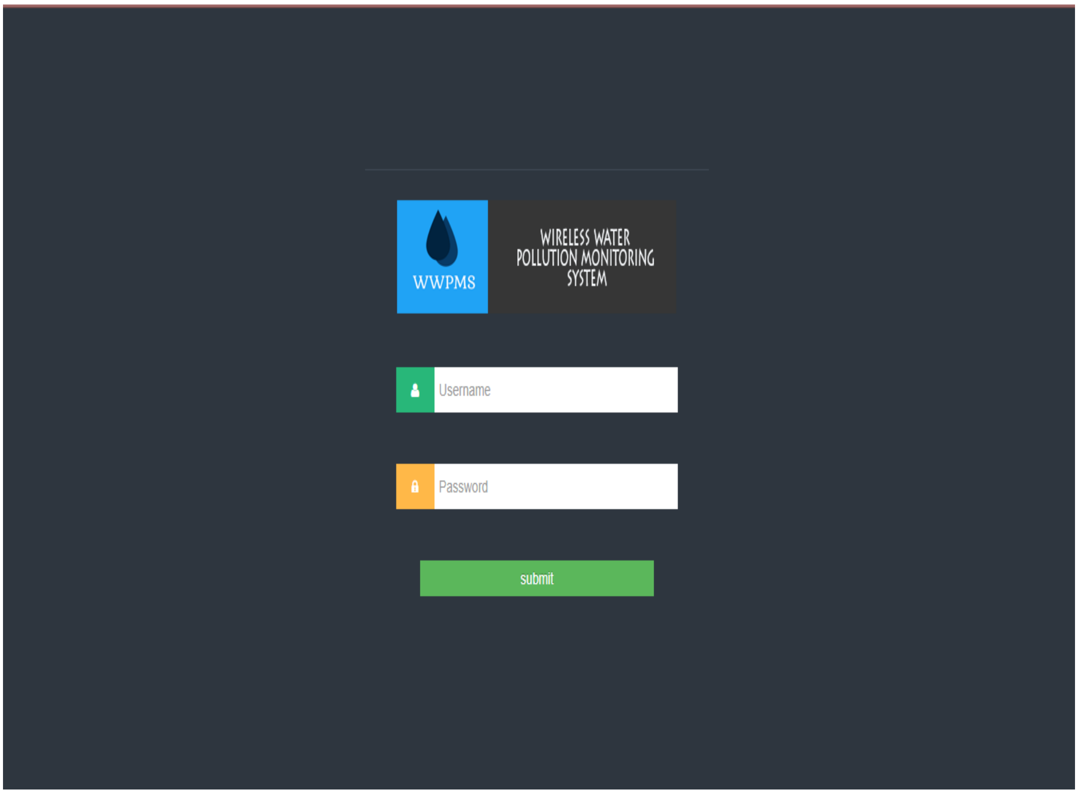


Figure 4.6: Login Interface

Figure 4.6 shows the login page for the staff to enter or use the system functionality. The login page required the user to fill up their username and password to access the system. The system will validate the information with the registered data. If the username and password are wrong it will display a dialog box for error message.

WWPMS Page

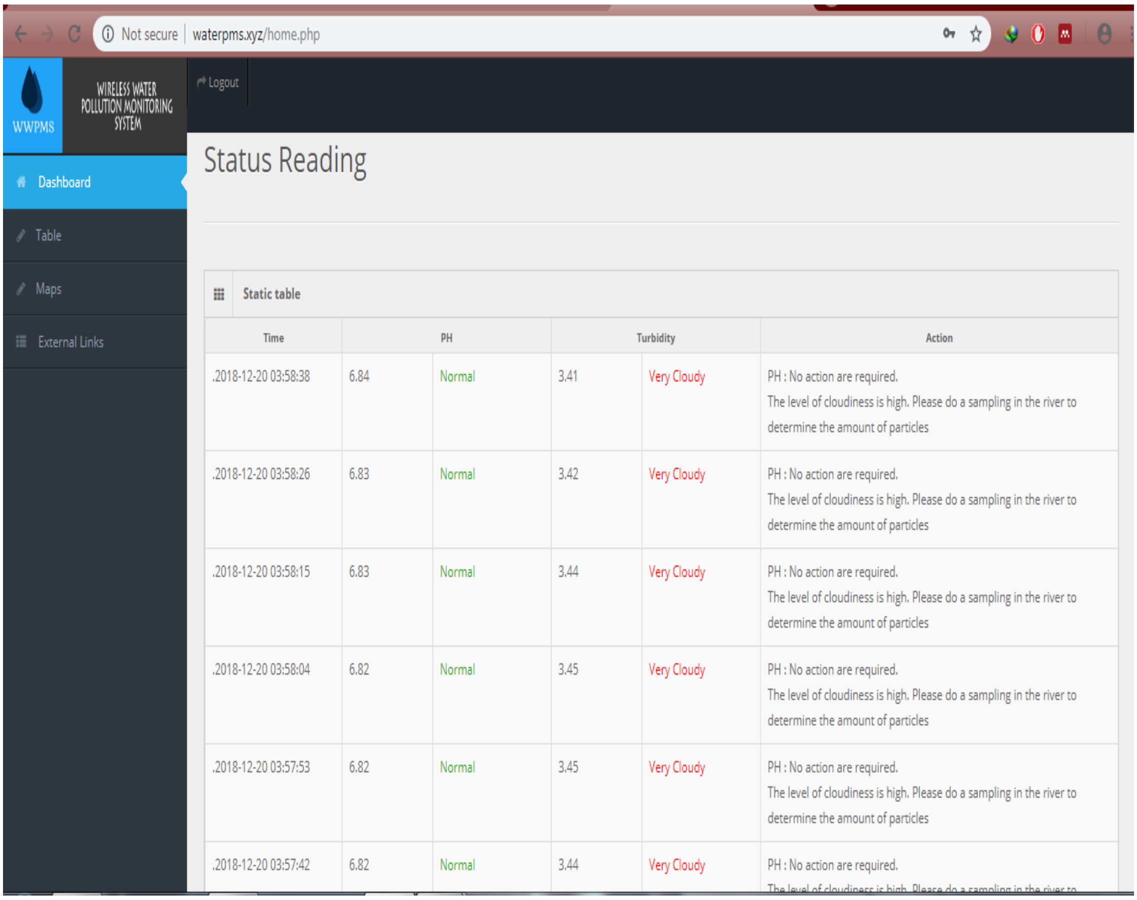


Figure 4.7: Home Page Interface

Figure 4.7 show the WWPMS Page interface. This page where it show the status reading of the river. This information were obtain from the database and the sensors devices send all collected data to the database. The maps button will show the user the location of the devices and finally external link where if user click it will link to another website. The status reading table in this page will show the value of PH, Turbidity and flow. Each of the value than are determined its quality and will show a status and action required if the value are not normal. Lastly, in the table consist of button. When user click the button a form pages will appear. User only need to enter the staff email so this will alert the staff to begin monitoring in the river.

Table Page

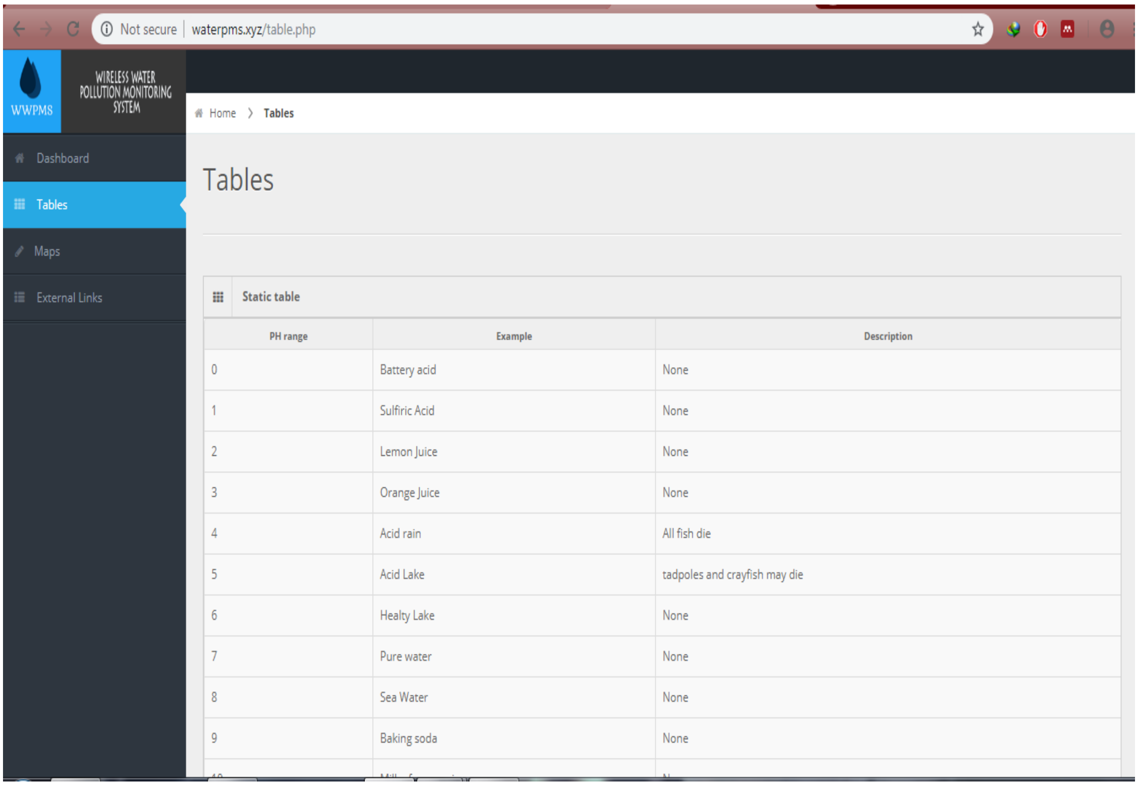


Figure 4.8: Table Page Interface

Figure 4.8 show the Table Page. The page shows the scale reading for PH, the reading of Turbidity and the reading of Flow. This page tell the information about each value of the sensors represent. For example Ph value of 0 is represent of battery acid and this type of value are acidic.

Map page

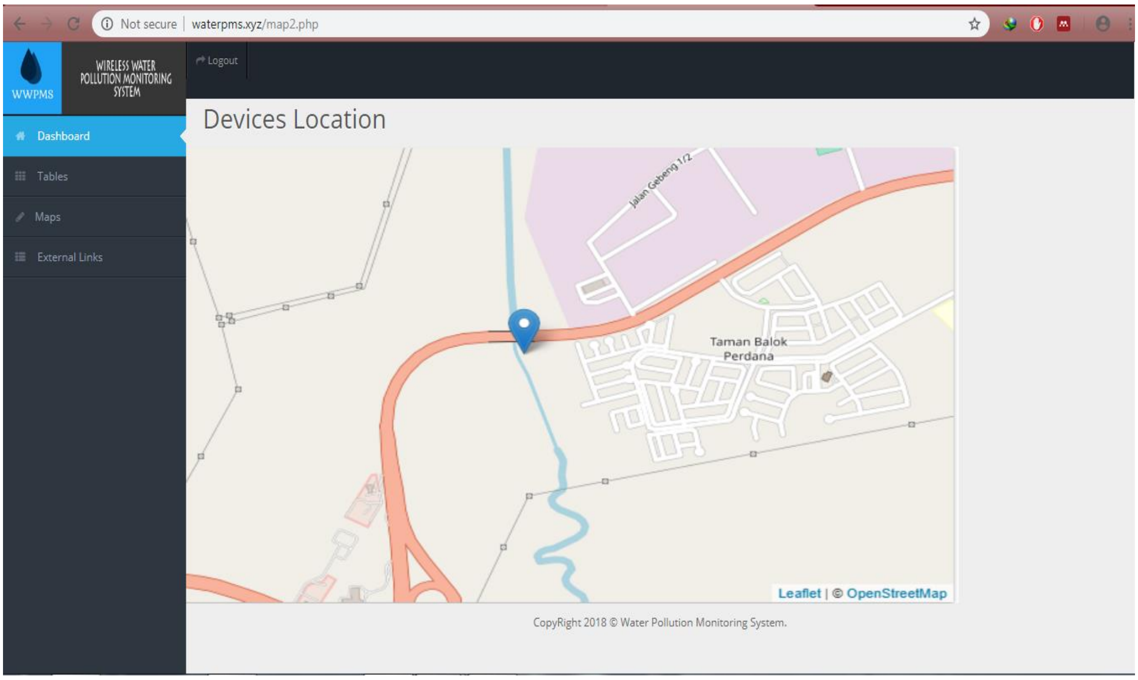


Figure 4.9: Map Page Interface

Figure 4.9 show the Map Page. In this page allow the user to see the location of the devices are located. The map images is link with google map. If user click the images it will go to the google map and shows the location of the devices.

4.2.2 Hardware Implementation

The hardware used in this system are Arduino Uno, ESP8266 WiFI Module, Water PH sensors, Turbidity sensors, Flow sensor, breadboard, Male to Male wires and Male to Female wires. Firstly, place a Male to Female on 3.3v, 5v and Ground port and jump to a breadboard. This will expand the function of the port because Arduino Uno only provided a few amounts of port and each sensor required this port to operated. Then connect the wires to each sensor based connect to breadboard. Make sure that all the components are correctly connected. Before start coding, make sure the main power supply is on to make sure all the hardware tools is on and the USB cable from PC to Arduino Uno are connected. After that, the hardware is ready to code. When the uploading process is done, open the serial monitor to shows the system process. Figure 4.10 shows the current system prototype.

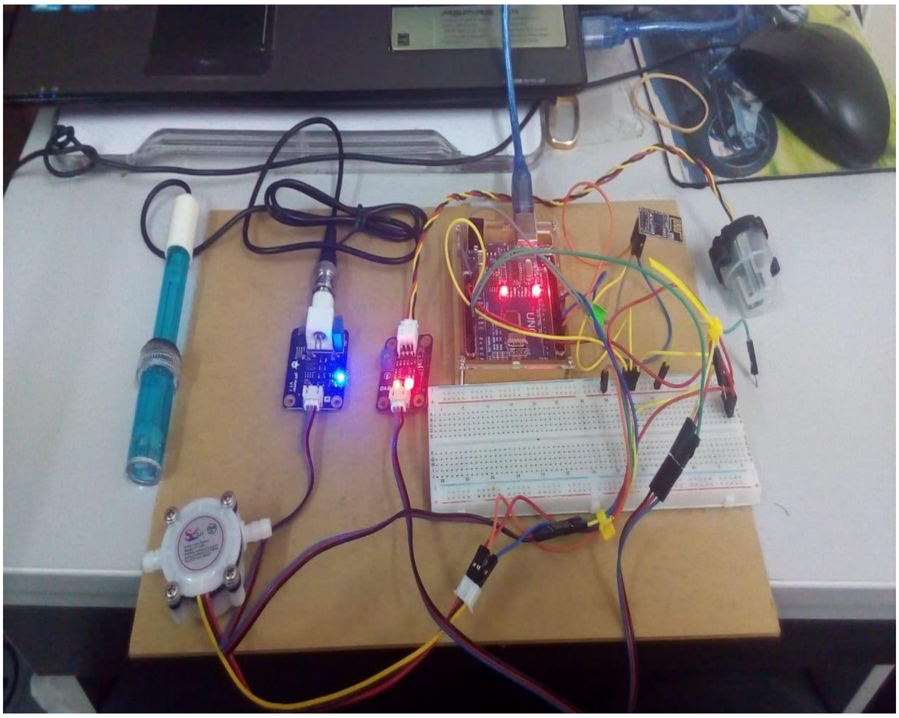


Figure 4.10: Current system on prototype.

A. Figure 4.11 shows the diagram connection between Arduino and water Ph sensor

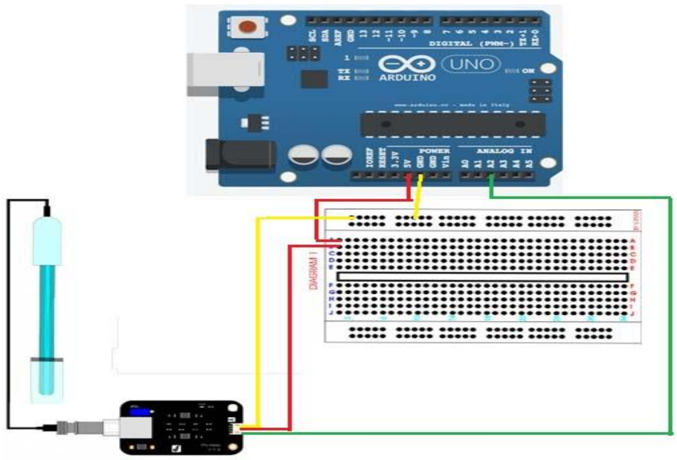


Figure 4.11: Ph sensor diagram

i. The code to run the Ph sensor.

```
#define SensorPin A0            //pH meter Analog output to Arduino Analog Input 0
#define Offset 0.00           //deviation compensate
#define LED 13
#define samplingInterval 20
#define printInterval 800
#define ArrayLenth  40    //times of collection
int pHArray[ArrayLenth];   //Store the average value of the sensor feedback
int pHArrayIndex=0;
void setup(void)
{
  pinMode(LED,OUTPUT);
  Serial.begin(9600);
  Serial.println("pH meter experiment!");    //Test the serial monitor
}
void loop(void)
{
  static unsigned long samplingTime = millis();
  static unsigned long printTime = millis();
  static float pHValue,voltage;
  if(millis()-samplingTime > samplingInterval)
  {
      pHArray[pHArrayIndex++]=analogRead(SensorPin);
      if(pHArrayIndex==ArrayLenth)pHArrayIndex=0;
      voltage = avergearray(pHArray, ArrayLenth)*5.0/1024;
      pHValue = 3.5*voltage+Offset;
      samplingTime=millis();
  }
  if(millis() - printTime > printInterval)    //Every 800 milliseconds, print a numerical,
convert the state of the LED indicator
  {
  Serial.print("Voltage:");
        Serial.print(voltage,2);
```

```
      Serial.print("    pH value: ");
  Serial.println(pHValue,2);
      digitalWrite(LED,digitalRead(LED)^1);
      printTime=millis();
  }
}
double avergearray(int* arr, int number){
  int i;
  int max,min;
  double avg;
  long amount=0;
  if(number<=0){
    Serial.println("Error number for the array to avraging!/n");
    return 0;
  }
  if(number<5){   //less than 5, calculated directly statistics
    for(i=0;i<number;i++){
      amount+=arr[i];
    }
    avg = amount/number;
    return avg;
  }else{
    if(arr[0]<arr[1]){
      min = arr[0];max=arr[1];
    }
    else{
      min=arr[1];max=arr[0];
    }
    for(i=2;i<number;i++){
      if(arr[i]<min){
        amount+=min;        //arr<min
        min=arr[i];
      }else {
        if(arr[i]>max){
```

```
          amount+=max;    //arr>max
          max=arr[i];
        }else{
          amount+=arr[i]; //min<=arr<=max
        }
      }//if
    }//for
    avg = (double)amount/(number-2);
  }//if
  return avg;
}
```

B. Figure 4.12 shows the result of PH.

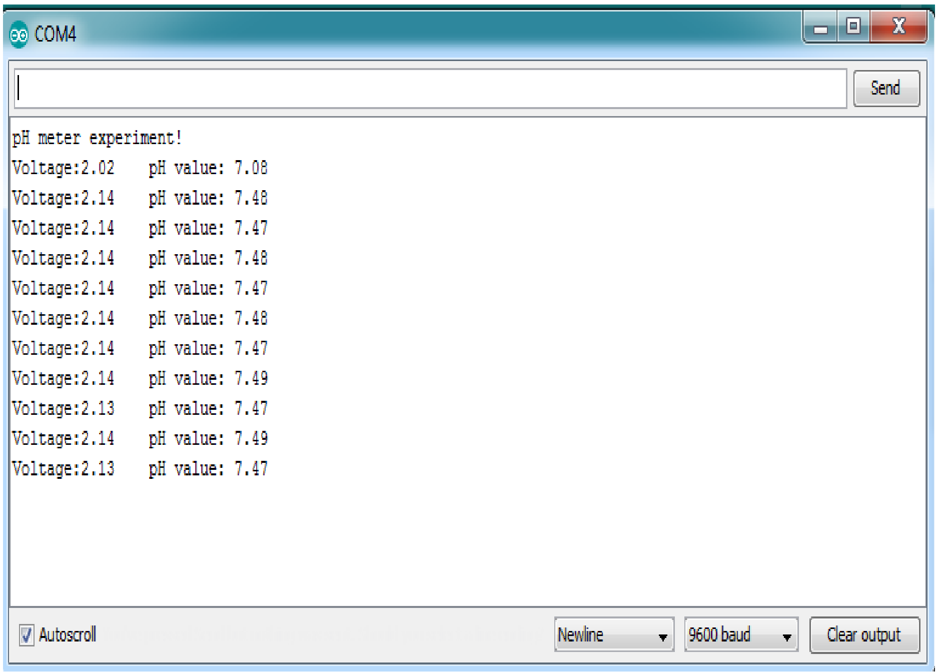


Figure 4.12: The result of PH sensor

C. Figure 4.13: shows the diagram connection between Arduino and water Turbidity sensor

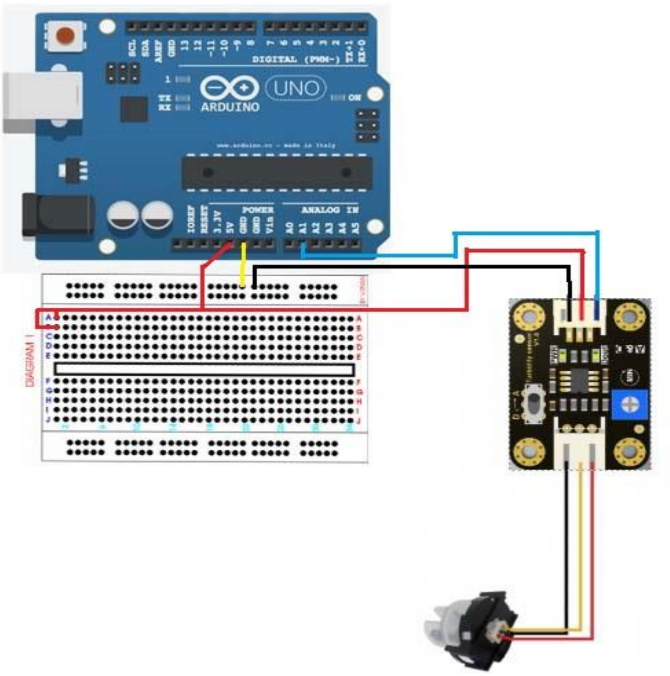


Figure 4.13: Turbidity Sensor Diagram

ii. The code of the Turbidity sensor.

```
int sensorValue = analogRead(A1);
float voltage;
void setup() {
  Serial.begin(9600); //Baud rate: 9600
}
void loop() {
  // read the input on analog pin 0:
  voltage = sensorValue * (5.0 / 1024.0); // Convert the analog reading (which
goes from 0 - 1023) to a voltage (0 - 5V):
  Serial.print("Turbidity:");
  Serial.println(voltage); // print out the value you read:
  delay(5000);
}
```

D. Figure 4.14: Show the result of turbidity sensor.

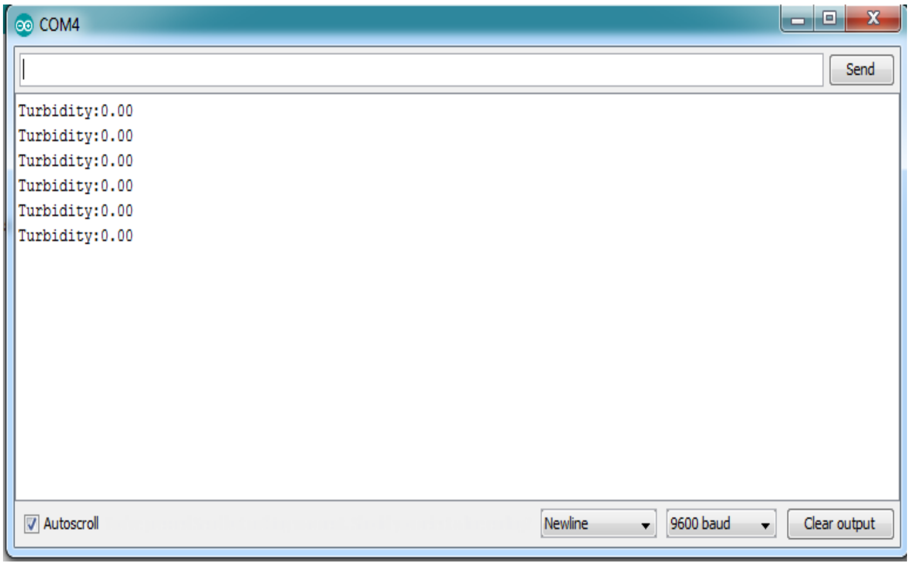


Figure 4.14: Result of Turbidity sensor

E. Figure 4.15 shows the diagram connection between Arduino and Flow sensor

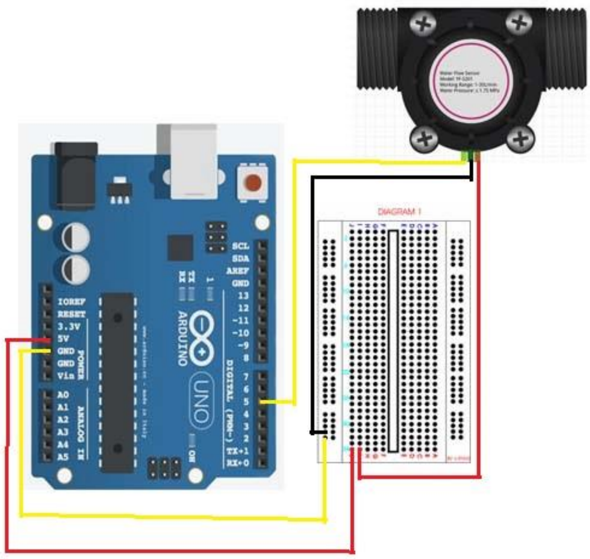


Figure 4.15: Flow sensor diagram

iii. The code of the Flow sensor

```
int flowPin = 4;    //This is the input pin on the Arduino
double flowRate;    //This is the value we intend to calculate.
volatile int count; //This integer needs to be set as volatile to ensure it updates correctly
during the interrupt process.

void setup() {
  // put your setup code here, to run once:
 pinMode(flowPin, INPUT);           //Sets the pin as an input
 attachInterrupt(0, Flow, RISING);  //Configures interrupt 0 (pin 2 on the Arduino Uno)
to run the function "Flow"
 Serial.begin(9600);  //Start Serial
}

void loop() {
  // put your main code here, to run repeatedly:

  count = 0;      // Reset the counter so we start counting from 0 again
  interrupts();   //Enables interrupts on the Arduino
  delay (1000);   //Wait 1 second
  noInterrupts(); //Disable the interrupts on the Arduino

   //Start the math
  flowRate = (count * 2.25);        //Take counted pulses in the last second and multiply by
2.25mL
  flowRate = flowRate * 60;         //Convert seconds to minutes, giving you mL / Minute
  flowRate = flowRate / 1000;       //Convert mL to Liters, giving you Liters / Minute

  Serial.println(flowRate);         //Print the variable flowRate to Serial

}
void Flow()
{
   count++; //Every time this function is called, increment "count" by 1
}
```

F. Figure 4.16: Show the result of Flow sensor

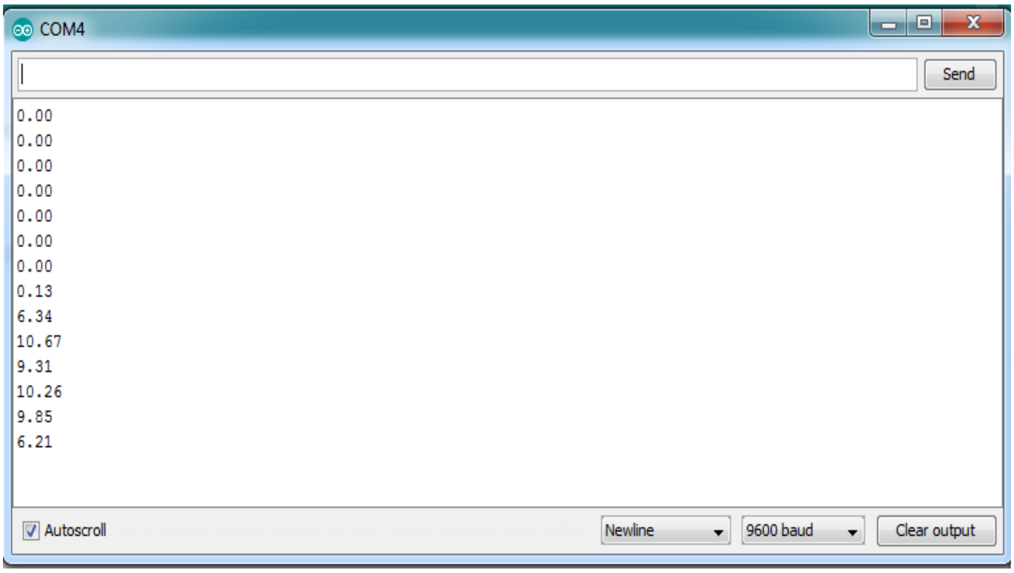


Figure 4.16: The result of Flow Sensor

G. Figure 4.18 shows the diagram connection between Arduino and GSM

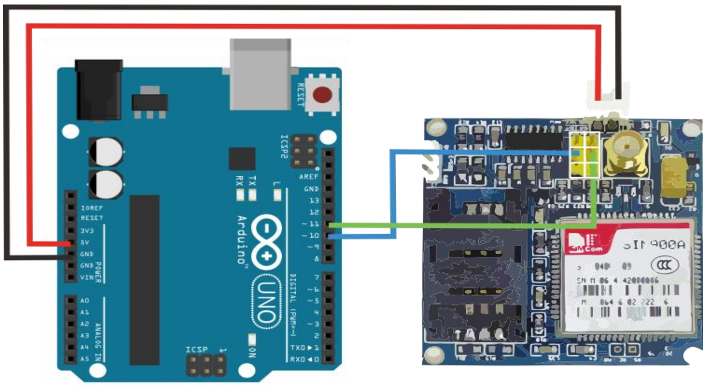


Figure 4.18: connection.

iv. The code of GSM to connect to database and send the data retrieve from sensor.

```
#include <SoftwareSerial.h>
SoftwareSerial sim900(10, 11); //(rx,tx)
int sensorValue = analogRead(A1);
float voltage;
int selisih[2];
int i=0;

void setup()
{
 sim900.begin(9600); //baudrate pada Shield = 19200
 Serial.begin(9600); //baudrate serial monitor
 delay(2000);

 status_gsm(); //prosedur memeriksa koneksi sim900 dengan arduino
 setting_kartusim(); //prosedur pengaturan GPRS sim900
}

void status_gsm()
{
 sim900.println(F("AT")); //AT command untuk memastikan koneksi dengan
Arduino
 if(sim900.find("OK"))
 {
  Serial.println(F("Koneksi dengan Arduino BERHASIL"));
 }
 else
 {
  Serial.println(F("Koneksi dengan Arduino GAGAL"));
  reset_gsm(); //prosedur power up sim900 (melakukan hard reset sim900)
  status_gsm();
 }
 delay(100);
}

void reset_gsm()
{
 pinMode(9, OUTPUT);
 digitalWrite(9,LOW);
 delay(1000);
 digitalWrite(9,HIGH);
 delay(2000);
 digitalWrite(9,LOW);
 delay(3000);
}

void setting_kartusim()
{
 sim900.println(F("AT+CREG=1")); //mengaktifkan registrasi jaringan
```

```
  delay(100);
  Serial.println(sim900.readString());
  sim900.println(F("AT+CGATT=1")); //masuk ke gprs servis
  delay(100);
  Serial.println(sim900.readString());
  sim900.println(F("AT+CIPSHUT")); //menonaktifkan gprs
  delay(100);
  Serial.println(sim900.readString());
  sim900.println(F("AT+CIPMUX=0"));//mengaktifkan single IP koneksi
  delay(100);
  Serial.println(sim900.readString());
  sim900.println(F("AT+CSTT=\"internet""\"")); //setting APN kartu sim
  delay(500);
  sim900.println(F("AT+CSTT?")); //memastikan setting APN benar
  delay(5000);
  Serial.println(sim900.readString());
  sim900.println(F("AT+CIICR")); //memulai koneksi GPRS
  delay(10000);
  Serial.println(sim900.readString());
  sim900.println(F("AT+CIFSR")); //request IP
  delay(5000);
  Serial.println(sim900.readString());
}

void koneksi()
{
  sim900.println(F("AT+CIPSTART=\"TCP\",\"waterpms.xyz""\",80"));
//memulai koneksi dengan server
  delay(1000);
  Serial.println(sim900.readString());
  if(sim900.find("OK"))
  {
    Serial.println(F("proses data"));
  }
  String link = "GET /input.php?PH_Value="+String(voltage)+"
HTTP/1.1\r\nHost: waterpms.xyz\r\n\r\n"; //tautan dengan metode GET

  sim900.print(F("AT+CIPSEND=")); //mengirim request data
  sim900.println(link.length()); //mengirim panjang tautan request data
  delay(500);
  if(sim900.find(">"))
  {
    sim900.print(link); //mengirim tautan ke server
    if(sim900.find("SEND OK"))
    {
      delay(100);
      while (sim900.available())
      {
        Serial.println(sim900.readString()); //feedback data (sesuai dengan keluaran
di browser)
```

```
      }
      sim900.println(F("AT+CIPCLOSE")); //stop koneksi
    }
    else
    {
      koneksi();
    }
  }
}

void loop()
{

  selisih[i]=sensorValue;
  Serial.print(i);
  Serial.print("    ");
  delay(1000);
  if(i==1)
  {
    if(selisih[1]==selisih[0])
    {

    }
    else
    {
      koneksi(); //prosedur mengirim data ke database
    }
    i=0;
  }
  else
  {
    i++;
  }

    // read the input on analog pin 0:
  voltage = sensorValue * (5.0 / 1024.0); // Convert the analog reading (which
goes from 0 - 1023) to a voltage (0 - 5V):
  Serial.print("Turbidity:");
  Serial.println(voltage); // print out the value you read:
  delay(500);
}
```

4.3 TESTING AND RESULT

This section shows the process of testing and results discussion about this project. This project will undergo the User Acceptance Test (UAT) to check and verify the system functionality according to the requirement purposed.

4.3.1 User Acceptance Test (UAT)

This section shows the details of a testing process using the User Acceptance Test (UAT). The system is being tested by the user to check the specification of the system. Approval of this testing implies that the user can successfully run the application according to the test plan.

(Refer Appendix B - User Acceptance Test (UAT).)

CHAPTER 5

CONCLUSION

5.1 INTRODUCTION

This chapter discussed about the overall conclusion about this project to develop the Wireless Water Pollution Monitoring System (WWPMS). This project was proposed and developed to replace the manual technique that need the authorities go to the nearby river or sea to collect sample of the water and send back to the lab to determine the amount of parameter in the water and the result will determine the water are clean or polluted. This method took a long time to determine the water quality and too much man power. Therefore, this project is developed to help the authorities to improve and provide the convenient way to detect pollution in a river. WWPMS are developed in two part which are web application and a devices. The purpose of this project is to give benefits to the staff of Jabatan Alam Sekitar (JAS). WWWPMS web application is used to display the data that receive from the sensors. They staff can view the current quality of the water. Furthermore, the system will also display a action based on the quality of the water. Meanwhile, the devices use to retrieve the data from the water are PH sensor used to measure the hydrogen-ion activity in water-based solutions. Others like Turbidity sensor are used to calculate the cloudiness of the water and Flow sensor to measure the flow rate or quantity of a gas or liquid moving through a river. This project was implemented step by step by following the selected methodology which is Waterfall methodology that is used as an implementation guideline for this project, starting from requirement analysis until testing phase. Lastly, all requirements of this project are successfully implemented.

5.2 PROJECT CONSTRAINTS

There are some constraints in implementing this project. The constraints for this project are as follows:

i. Limited time

The implementation of this project required more time to ensure that the application can be add more function. Currently the WWPMS have a few features such as Login, View table, Graph and Maps. This system also only display collected data for one location of river. There are many other features that could be added in this application but due to the time constraint, only these few features were successfully implemented.

ii. WWPMS requires an internet access.

WWPMS develop in two platforms which is the web application and devices. Due to devices send data to database, XAMPP Server is used as the intermediate database to store the data that use by this application. Therefore, internet connection is required to make sure the application can access to the data in the server. Also, the devices Wi-Fi module need a stable internet connection to send the data. Other than that, the distance between Wi-Fi module devices and internet also make this system a drawback because the longer the distance the Wi-Fi will be unreachable.

iii. WWPMS devices sensors malfunction.

WWPMS sensors sometimes stop working due to hardware failure or a loose cable between the Arduino and sensors.

5.3 FUTURE WORK

Based on the constraints faced in current implementation, several enhancements and additional features are list out where can be developed into this application for the future improvement of WWPMS.

i. Add the new features to the application which is allow the staff to view data with Real time graph. Others features like sending alert to staff for monitoring the river using a SMS message that tells the staff the current condition of the water.

ii. Add a new device that can send the data retrieve from sensors to web application. For example using a GSM can connect with the database and system because it have long distance connection compare to Wi-Fi module.

iii. Add a more voltages of batteries for the devices due to devices only used a small voltage to support all the sensors. Also, to give the devices a durable amount of time to operate.

REFERENCES

Adu-Manu, K. S., Tapparello, C., Heinzelman, W., Katsriku, F. A., & Abdulai, J.-D. (2017). Water Quality Monitoring Using Wireless Sensor Networks: Current Trends and Future Research Directions. *ACM Trans. Sen. Netw.*, *13*(1), 4:1--4:41. http://doi.org/10.1145/3005719

Daud, H. (2010). Water Quality (River) Monitoring System/ Programme and Pollution Control, 1–52.

Kamble, R., Kakade, S., Mahajan, A., & Bhosale, A. (2017). Automatic Water Quality Monitoring System Using Arduino. *International Journal of Recent Innovation in Engineering and Research Scientific Journal*, 87–90. Retrieved from https://ijrier.com/published-papers/volume-2/issue-2/automatic-water-quality-monitoring-system-using-arduino.pdf

Wei, D., Liu, P., Lu, B., & Guo, Z. (2012). Water quality automatic monitoring system based on GPRS data communications. *Procedia Engineering*, *28*(2011), 840–843. http://doi.org/10.1016/j.proeng.2012.01.820

Markovic, N. (2009). Sensor web for river water pollution monitoring and alert system. *12th AGILE International …*, 1–9. Retrieved from http://www.ikg.uni-hannover.de/agile/fileadmin/agile/paper/120.pdf

Daigavane, V. V, & Gaikwad, M. A. (2017). Water Quality Monitoring System Based on IOT, *10*(5), 1107–1116. https://doi.org/https://www.ripublication.com/awmc17/awmcv10n5_24.pdf

Hu, X., Wang, J., Yu, Q., Liu, W., & Qin, J. (2008). Water Quality Monitoring System Using Zigbee Based Wireless Sensor Network. *October*, *9*(October), 1367–1370.

Borden, C., & Roy, D. (2015). Water Quality Monitoring System Design. *International Institute for Sustainable Development*.

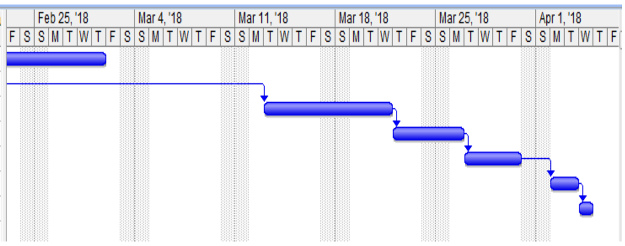
Barabde, M. N., & Danve, S. R. (2015). Continuous Water Quality Monitoring System for Water Resources at Remote Places, 3(3), 172–177.

P. M. Pujar, H. H. Kenchannavar, and U. P. Kulkarni, "Wireless Sensor Network based Water Monitoring Systems: A survey," *Proc. 2016 2nd Int. Conf. Appl. Theor. Comput. Commun. Technol. iCATccT 2016*, pp. 155–159, 2017.

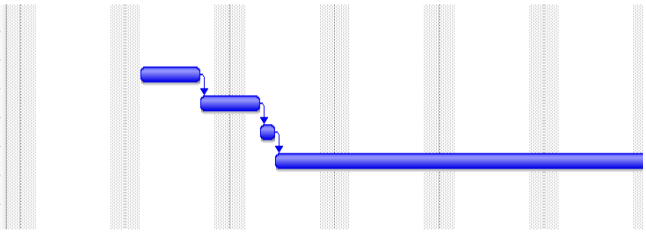
T. I. Salim, H. S. Alam, R. P. Pratama, I. A. F. Anto, and A. Munandar, "Portable and online water quality monitoring system using wireless sensor network," *Proc. 2nd Int. Conf. Autom. Cogn. Sci. Opt. Micro Electro-Mechanical Syst. Inf. Technol. ICACOMIT 2017*, vol. 2018–Janua, pp. 34–40, 2018.

APPENDIX A
GANNT CHART

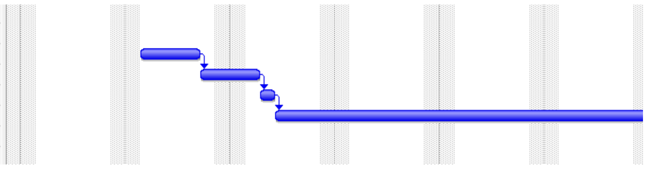
	Task Name	Duration	Start	Finish	Predecessors	Resou
1	Planning Phase	14 days	Mon 2/12/18	Thu 3/1/18		
2	Confirm Project title	1 day	Mon 2/12/18	Mon 2/12/18		
3	Prepare Chapter 1(Introducti	7 days	Tue 3/13/18	Wed 3/21/18	2	
4	Identify problem statement	3 days	Thu 3/22/18	Mon 3/26/18	3	
5	Clarify objective of system	4 days	Tue 3/27/18	Fri 3/30/18	4	
6	Identify the scope of project	2 days	Mon 4/2/18	Tue 4/3/18	5	
7	Chapter 1 Submission	1 day	Wed 4/4/18	Wed 4/4/18	6	
8						



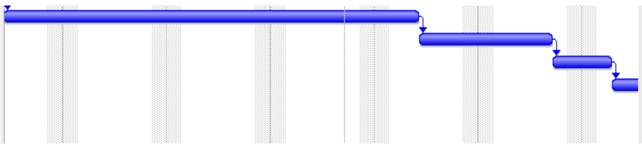
Analysis Phase	20 days	Thu 4/5/18	Wed 5/2/18	7	
Prepare chapter 2	7 days	Thu 5/3/18	Fri 5/11/18	9	
Analysis existing system	4 days	Mon 2/12/18	Thu 2/15/18		
make comparison of system	2 days	Fri 2/16/18	Mon 2/19/18	11	
Chapter 2 Submission	1 day	Tue 2/20/18	Tue 2/20/18	12	
Prepare Chapter 3(Methodol	25 days	Wed 2/21/18	Tue 3/27/18	13	
Define Methodology of projec	3 days	Wed 3/28/18	Fri 3/30/18	14	
identify system requirement a	7 days	Mon 4/2/18	Tue 4/10/18	15	



Analysis Phase	20 days	Thu 4/5/18	Wed 5/2/18	7	
Prepare chapter 2	7 days	Thu 5/3/18	Fri 5/11/18	9	
Analysis existing system	4 days	Mon 2/12/18	Thu 2/15/18		
make comparison of system	2 days	Fri 2/16/18	Mon 2/19/18	11	
Chapter 2 Submission	1 day	Tue 2/20/18	Tue 2/20/18	12	
Prepare Chapter 3(Methodol	25 days	Wed 2/21/18	Tue 3/27/18	13	
Define Methodology of projec	3 days	Wed 3/28/18	Fri 3/30/18	14	
identify system requirement a	7 days	Mon 4/2/18	Tue 4/10/18	15	



Design Phase	20 days	Wed 4/11/18	Tue 5/8/18	16	
Design system architecture	7 days	Wed 5/9/18	Thu 5/17/18	17	
Design Context Diagram	2 days	Fri 5/18/18	Mon 5/21/18	18	
Design Use Case Diagram	5 days	Tue 5/22/18	Mon 5/28/18	19	
Chapter 3 Submission	1 day	Tue 5/29/18	Tue 5/29/18	20	
PSM 1 Submission	1 day	Tue 5/29/18	Tue 5/29/18		



APPENDIX B
USER ACCEPTANCE TEST (UAT)

1.0 TESTING REPORT

The purpose of this section is to record the User Acceptance Test (UAT) process for Mobile Receipt System. Approval of this testing implies that reviewers are confident that following the execution of the test plan, the resulting system will be considered fully-tested and eligible for implementation. Any error or problems found by the user are noted on this form.

1.1 Test Case for web Application Module

Table 1.0 shows the for the user login module that used by users to use the WWPMS system.

Test Case	Test Data	Expected Result	Actual Result	Pass/Fail	Comment
Login with correct username and password	Username: admin Password: admin	Successfully login And redirect to Home Page	Login success and redirect to expected page	Pass	-
Login with incorrect username	Username: user12	Popup error message will be show	Registration was failed	Pass	-

and password	Password: asd				

Table 1.1 shows the for the view water condition of WWPMS.

Test Case	**Test Data**	**Expected Result**	**Actual Result**	**Pass/Fail**	**Comment**
View the water condition by clicking Dashboard.	Click Dashboard Button	View the collected data retrieve from sensors	. View the collected data retrieve	Pass	-
View the graph by clicking the graph button	Click graph button	Redirect to Graph pages and display the graph based on collected data..	Redirect to Graph pages and display the graph	Pass	-
Send information to staff via email.	Click submit	Successfully redirect to form page with all the	Successfully redirect to form page.	Pass	

View for External Link	Click button link inside external link menu. For example click (JAS) button.	Redirect to the (JAS)Jabatan Alam Sekitar website.	Can redirect to the (JAS)Jabatan Alam Sekitar website.	Pass	