Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF IOT BASED WUDHU WATER MANAGEMENT SYSTEM USING ESP32 FOR GREEN MOSQUE

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Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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DEVELOPMENT OF IOT BASED WUDHU WATER MANAGEMENT SYSTEM USING ESP32 FOR GREEN MOSQUE

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A project report submitted in partial fulfilment of the requirement for the degree of

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2022

DECLARATION

I declare that this project report entitled "Development Of Iot Based Wudhu Water Management System Using ESP32 For Green Mosque" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Student Name : Muhamad Zulfaqar Bin Ya'akup

Date : 27/01/2023

APPROVAL

I approve that this Bachelor Degree Project 2 (PSM2) report entitled “Development of IoT Based Wudhu Water Management System using ESP32 for Green Mosque” is sufficient for submission.

Signature : .....

Supervisor Name : Ts. Fakhrullah Bin Idris

Date : 27/01/2023

DEDICATION

This research is dedicated to my parents, Ya'akup bin Man and Noor Harfah binti Jali, who have always encouraged me. They have given me the encouragement and motivation that I need to not give up in doing this project. To my supervisors, Ts Fakhrullah bin Idris, I sincerely thank you for guiding me throughout the project. Without their love and support, this project would not have been possible.

ABSTRACT

Due to Muslims' need for ablutions, mosques consume a lot of clean to processed drinking water. During ablution, they usually use ten to twelve litres of water five times a day. By reusing post-ablution water in the ablution tub after the ablution procedure, the Wudhu Water Management System will reduce water consumption during the ablution process. During the ablution procedure, this device will regulate the flow and volume of water. The goal of this project is to design and construct a prototype ablution system that can reduce water usage during the ablution process by reusing post-ablution water after the ablution procedure has been completed. To manage the water flow, a ESP32 will be used as a controller. The ablution tub's water flow will be controlled by a water pump, and sensors will monitor the water volume in the storage and ablution tubs to ensure that there is adequate water for the ablution process. For monitoring purposes, all data is shared to the cloud. The system should only work at predetermined times based on prayer times and when users are recognised. In a Graphical User Interface (GUI), the results and analysis of data concerning the volume and flowrate of water during the ablution process will be shown.

ABSTRAK

Disebabkan keperluan umat Islam untuk berwuduk, masjid mengambil banyak air minuman yang bersih dan diproses. Semasa berwuduk, mereka biasanya menggunakan sepuluh hingga dua belas liter air lima kali sehari. Dengan menggunakan semula air selepas wuduk di dalam tab wuduk selepas prosedur wuduk, Sistem Pengurusan Air Wuduk akan mengurangkan penggunaan air semasa proses wuduk. Semasa prosedur wuduk, alat ini akan mengawal aliran dan isipadu air. Matlamat projek ini adalah untuk mereka bentuk dan membina prototaip sistem wuduk yang dapat mengurangkan penggunaan air semasa proses wuduk dengan menggunakan semula air selepas wuduk dimana prosedur wuduk selesai. Untuk menguruskan aliran air, ESP32 akan digunakan sebagai pengawal. Aliran air tab wuduk akan dikawal oleh pam air, dan sensor akan memantau isipadu air dalam simpanan dan tab wuduk bagi memastikan terdapat air yang mencukupi untuk proses wuduk. Untuk tujuan pemantauan, semua data dikongsi ke 'Cloud'. Sistem hendaklah hanya berfungsi pada waktu yang telah ditetapkan berdasarkan waktu solat dan apabila pengguna dikesan menggunakan sistem tersebut. Hasil dan analisis data tentang isipadu dan kadar alir air semasa proses wuduk akan ditunjukkan dalam GUI .

ACKNOWLEDGE

First, I cannot express enough thanks to my supervisor, Mr Fakhrullah Bin Idris who gave me the golden opportunity and also for their valuable advice, all over this project.

I also like to thank Universiti Teknikal Malaysia Melaka (UteM) and for providing me all the required resources and funds for the project. All in all, i want to express my gratitude to everyone who participated in this project and offered comments to help me improve it.

Lastly, I would like to show my gratefullness to my parents, relatives and friends for always being there for me and supporting me in all of our endeavours.

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δ	-	Voltage angle
	-	
	-	
	-	
	-	
	-	
	-	
	-	

LIST OF ABBREVIATIONS

V	-	Voltage
	-	
	-	
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	-	
	-	
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CHAPTER 1

INTRODUCTION

1.1 Background

As the tap is usually left running, much good water is wasted in the process. Considering the unnecessary wastage, a simple recycling system can be designed to collect, treat and reuse ablution water in this system so that the water can be reused for ablution. A simple ablution water output prediction model was next proposed to more accurately quantify the capacity and efficiency of this water recycling system.

1.2 Problem Statement

The mosque is a place of worship for Muslims. Mosques nowadays many facilities have been provided by the government. One of them is electricity, water for ablution and so on. But the facilities provided are not used properly. So the main problem for this study is the process during ablution where the use of water is widely used. Ablution is a process that Muslims need to do before performing prayers. However, excessive use of water during ablution is strongly discouraged. The water consumptions during ablution are range from 9 liters of water per day per ablution [3] for one worshipper will use 45 liter of treated water for one day. Hence, this study will discuss the amount of water consumption and how to deal with water wastage during ablution and this project will focus at Masjid Sayyidina Abu Bakar, University Technical Malaysia Malacca .

1.3 Project Objective

The aim of the study is to measure the amount of water wasted and disposed in the ablution process in the mosques of the study area, without any treatment for reuse, and to further investigate the way to reduce the water consumption during ablution :

a) To survey the usage of water during ablution per person in mosque.

b) To develop a system that can reduce water wastage during ablution.

c) To investigate the methods and applications for recycling ablution water

1.4 Scope of Project

The major purpose of this study is to improve water demand management in general public buildings, such as mosques across the world but this project will focus on Sayyidina Abu Bakar Mosque, University Technical Malaysia Malacca. This project would reduce water consumption during ablution process by reusing post ablution water in ablution tub after finish the ablution process. This study calculates the potential savings that can be made by recommending regulations that encourage mosques to use proper equipment and procedures.

Among the equipment that will use in this project is ESP32 as a controller to control water flow. The ablution tub's water flow will be controlled by a water pump, and sensors will monitor the water volume in the storage and ablution tubs to ensure that there is enough water for the ablution process. For monitoring purposes, all data is shared to the cloud. The system should only work at predetermined times based on prayer times and when users are recognized. In a graphical user interface (GUI), the results and analysis of data concerning the volume and flowrate of water during the ablution process will be shown.

This study uses a simple way to measure the amount of water used in the mosque, including during ablutions, and it also indicates the savings that can be made. The study

proposes potential water-saving solutions, investigates the acceptability of reusing water in mosques, and finally presents rules for controlling water consumption in public buildings, such as mosques. The purpose of this project is to address the following research questions: 'How can water waste during ablution in the mosque be reduced?' The study's aims in this case study are summarised by the observed knowledge gaps.

1.5 Organization

Introduction, literature review, methodology, preliminary result, and conclusion and recommendation are five chapters of this study. All chapter will go over the research in greater depth.

1.6 Thesis Organization (Chapter 1-5)

The first chapter is about the project introduction. The project history, problem statement, objectives, and research scope are all included in this chapter. This chapter will review and give all of the summary facts pertaining to this project.

For chapter 2, it’s regarding earlier research that’s relevant to this study. It’s also referred to as a literature review. The approaches and some of methods utilized by other researchers in their studies are discussed in this chapter. This is crucial information for studying and comparing the characteristics of the past research that could serve as a guideline for this project.

For chapter 3 focus on the methodology which is will comprise the project’s flowchart, as well as the software and hardware that will be employed. At the same time, it’s about understanding how the process works, as well as how to properly plan and implement a project.

For chapter 4 will focus on expected results and analysis where the predicted results will be the output before the project is fully completed. Expected result is very necessary to know the desired output and also the concept used. With a description of the expected result, the output and data obtained are easy to understand.

Lastly, chapter 5 is the conclusion and overall understanding of chapters 1 to 4.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Prayer is the second pillar of Islam, so it is obligatory for every Muslim around the world. Before performing the five daily prayers, there are things that need to be done which is ablution. Ablution is a process where a worshipper performs minimum 5 times daily at mosque, using water. Generally treated water are use as it professes the quality and perceptions of cleanliness. In order to exalt purity and cleanliness before each prayer, ablution is a must-do activity for Muslims.

2.2 Green Mosque

Significant global climate changes affecting humans and ecosystems directly or indirectly are now a hot topic to discuss. The concept of building sustainability is very useful for increasing efficiency in the use of resources such as water while reducing adverse implications to human health and the environment.

On 20 October 2009, the Ministry of Works was directed to ensure all new government buildings were integrated with the Malaysian green building index (GBI) criteria and this research worked on efforts to create conceptual sustainability for mosque buildings leading to the formation of the green mosque index (GMI)[1]. Water Efficiency is one of the sustainable practices is efficiency of water consumption [1]. Efficiency in using water is very important to get benefits such as long -term use of water. If the use of water is not practiced

so well then humans will experience a water crisis in the future. As the use of water in the mosque is very much used for Muslims to perform ablution to perform obligatory prayers.

On 11th November 2017, MUI (Indonesian Council of Ulama) and DMI (Indonesian Mosque Council) have launched the national program named eco masjid [2]. The purpose of establishing an eco-masjid is a sustainable mosque program through efforts to preserve natural resources such as water. Among the methods used is water conservation (WAC), water is the main use in mosques for ablution. The Azzikra mosque has used a water recycling system to recycle used water from ablution water and recycled water will be used for toilets, kitchens and watering flowers. Figure 2.2.1 is the water recycling system at Azzikra Mosque [2].

Figure 2.2.1: Recycling System. Adapted from [2]

Although green mosques have been established in some mosques to deal with water waste but this method still cannot be practiced by some communities. So the most suitable system is where recycling ablution water can reduce water waste.

2.3 Ablution water usage

Even though the prophet preach to save water during ablution process, in reality the water consumption are quite high. Based on study by multiple researchers, the water consumptions during ablution are range from 5-9 liters of water per day per ablution [3][4][5]. Table 1 shows the usage of water.

Table 1: Journal that related with water usage per ablution

Author	Area	Usage (liters)	Measurements method
N.H Johari et all [3]	Malaysia	9	- The way of measurement is field observation which is measure the ablution water at bucket.
Roubi A. Zaied [4]	Egypt	7	- Video recorded by total time of each group is computed for each case and the statistical calculation are used.
Ahmad Faisol Yusof et all [5]	Malaysia	5	- This measurement is using field observation and interview method.

So with the data given it shows the consumption of water during ablution. Each survey done has a difference of data obtained so with a range of 5-9 liters we can know how much consumption of water per day per ablution. Futhermore, it was discovered that 22.7–28.8% of ablution water is utilised for foot washing, with the biggest water waste occurring during

face washing and 30–47% of water used in ablution from taps is wasted [3]. Every Muslim is required to pray five times a day, and it is one of Islam's pillars.

Mosques have multiplied throughout the Muslim world to allow the five daily prayers and have become a symbol of Islamic civilisation. Mosque water consumption varies monthly [4], normally higher when the peak season and growing as populations grows example in one the mosque in Perak as illustrated in Table 2.

Table 2 : A Mosque's Monthly water consumption bills . Adapted from [4]

NO	DATE OF BILL	COMSUMP-TION (m^3)	BILL (RM)	NO. OF DAY	DAY	EVENT
1	16022011	137	119.91	57	WEDNESDAY	
2	13042011	202	186.86	56	WEDNESDAY	
3	10062011	214	199.22	58	FRIDAY	30072011 1st RAMADHAN
4	8082011	237	222.91	59	MONDAY	30082011 HARI RAYA AIDILFITRI
5	11102011	290	277.50	64	TUESDAY	06112011 HARI RAYA AIDILADHA
6	8122011	282	269.26	58	THURSDAY	
7	10022012	242	228.06	64	FRIDAY	
8	10042012	199	183.77	60	TUESDAY	
9	13062012	240	226.00	64	WEDNESDAY	21072012 1st RAMADHAN
10	9082012	265	251.75	57	THURSDAY	19082012 HARI RAYA AIDILFITRI
11	9102012	277	264.11	61	TUESDAY	26102012 HARI RAYA AIDILADHA
12	18122012	274	261.02	70	TUESDAY	
13	13022013	211	196.13	57	WEDNESDAY	
14	10042013	232	217.76	56	WEDNESDAY	
15	18062013	312	314.58	69	TUESDAY	10072013 1st RAMADHAN
16	22082013	387	377.41	65	THURSDAY	08082013 HARI RAYA AIDILFITRI
17	21102013	305	102.10	60	MONDAY	15102013 HARI RAYA AIDILADHA
18	21122013	275	91.90	61	SATURDAY	
19	19022014	310	103.80	60	WEDNESDAY	
20	20042014	480	161.60	60	SUNDAY	
21	21062014	576	194.24	62	SATURDAY	29062014 1st RAMADHAN
22	19082014	489	164.66	59	TUESDAY	28072014 HARI RAYA AIDILFITRI
23	21102014	391	131.34	63	TUESDAY	05102014 HARI RAYA AIDILADHA

2.4 Ablution tap station

When the ritual involves the use of water , the muslims introduced a specific place to perform ablution, to facilate muslims to perform this ritual. An ablution station has many design variation. Figure 2.4.1 show the variation of ablution station.

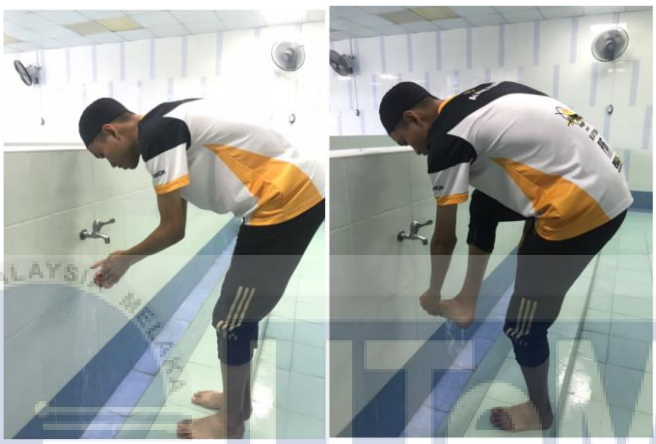


Figure 2.4.1 : Ablution station at Sayyidina Abu Bakar Mosque

Water is important resource used in the mosque for many activities such as for ablution, cleaning, landscape watering and toilet. So this subtopic will focus on the ablution part. Ablution has become synonymous with water because in terms of language ablution is the act of using water on a particular body to cleanse oneself of small impurities[6].Since this ablution ritual involves the use of water, so Muslims build a place or station to take the ablution. The place or station of ablution is very important to facilitate the drainage according to the correct place. Each mosque has a different material to build an ablution place. Mosques not only provide practical engineering solutions for improving sustainable living, but they also adhere to Islamic ideals of wise use of natural resources. Figure 2.4.2 showing the ablution tub at Masjid Saiyyidina Abu Bakar, Universiti Teknikal Malaysia Melaka.

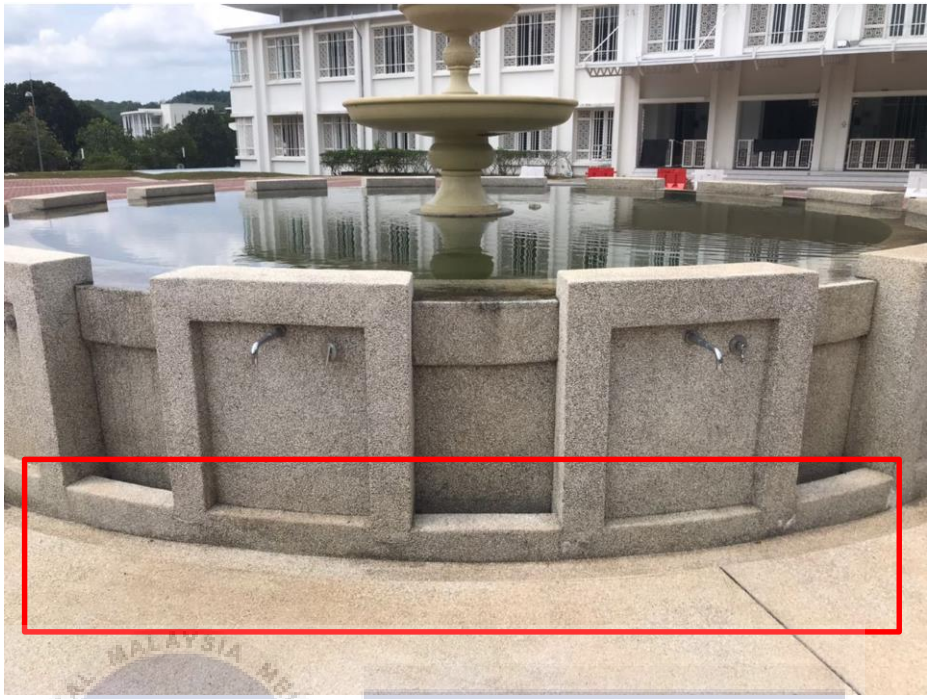
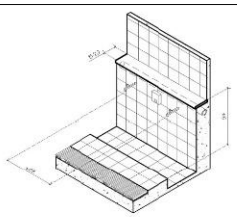
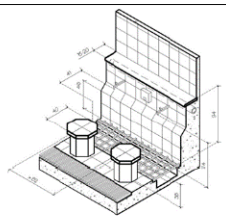
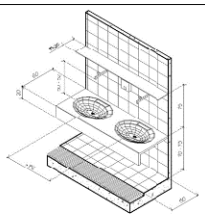
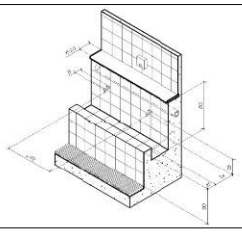


Figure 2.4.2 : Example of water passage after ablution

There has 16 taps where 16 people can take ablution at a time. The diameter of this ablution tub is 7-8 meters. In Figure 2.4.2 in the red box shows the passage of water after ablution and through the drainage of water such as drain. Table 1 shows the design for ablution place designed by Mokhtar [6]. The purpose of their ablution tub is to make it easier for Muslims to take ablution and provide comfort for them.

Table 3 : Conventional Ablution Design by Mokhtar [6]

	Model 1	Model 2	Model 3	Model 4
Ablution Design				
Standard Features	Faucet / Platform / Top Shelf	Faucet / Platform / Top Shelf	Faucet / Platform / Top Shelf	Faucet / Platform / Top Shelf
Additional Features	Drain	Seat / Covered Drain	Lavatory / Pipe System Drain	Barrier / Drain

2.5 Post Ablution Water

A clean ablution water also important to Muslims for taking ablution before performing prayers. Ablution water must be clean from any impurities because the water is used to wash part of the body. Before the water is used, the clean water is stored in a tank. Each mosque has a tank for storing water before ablution. Figure 2.5.1 below showing the example of a place to store clean water before being used for ablution at Sayyidina Abu Bakar Mosque.

Figure 2.5.1: Place to store a clean water.

Ablution rituals use large amounts of water, where ablution water from mosques in India is usually dumped untreated into drainage channels [7]. During ablution, the pipes are usually allowed to flow in large amounts so that sufficient clean water will be wasted in the process. Water after ablution is water that has been used by Muslims after completing ablution and the post ablution water is mostly clean so if it is not filtered for other uses then a lot of wastage occurs. Water after ablution is less polluted and can be re -filtered with

simple physical treatment and disinfection process is also reused for non-potable consumption [8]. Figure 2.5.2 is example of post ablution water.

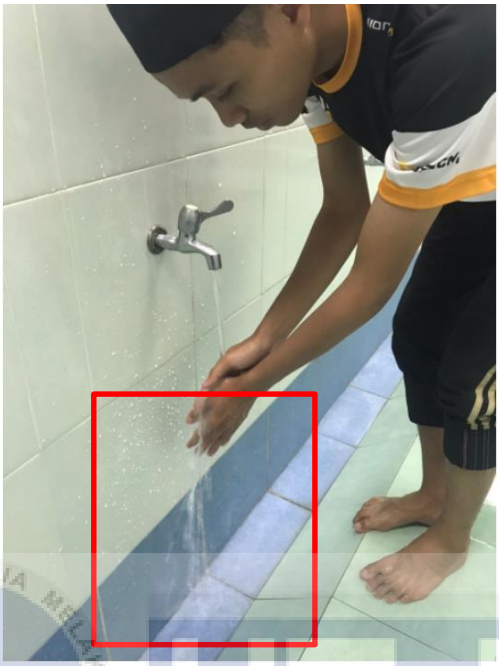


Figure 2.5.2 : An example of post ablution water that will be channeled to the drain.

Indeed the water after ablution is water that can be reused after ablution. The law regarding the reuse of ablution water is much questioned by many parties but this will be discussed in the next subtopic.

Treated water can be recycled for toilet flush use or for watering crops. Inlet water demand and sewage generation can be reduced and thus the cost of wastewater treatment and the resulting impact on the natural environment [9]. Figure 1 below is about the conceptual model for PAW (Post Ablution Water) recycling system.

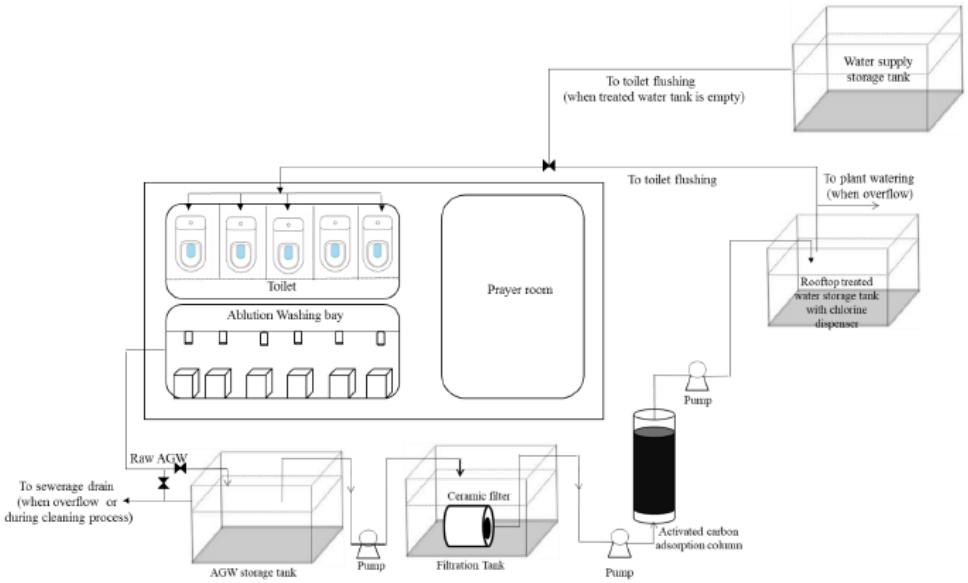


Figure 2.5.3 : Conceptual model for PAW (Post Ablution Water) recycling system

Figure 2.5.3 showing the water flow in the system and the components of the PAW recycling conceptual model. The model was created with the intention of recycling treated PAW for toilet flushing. PAW collecting and storage tank, low-cost ceramic filtering unit, activated carbon adsorption column, chlorine dispenser, and overhead treated PAW storage tank are the major components of the sustainable PAW recycling system. The PAW water was gravitationally pushed to the PAW storage tank through the disposal pipelines. The PAW water was then pumped to the ceramic filtration tank, where the suspended and colloidal particles were removed. To remove the organics, the water was run through an activated carbon adsorption column after filtering. The water was then pumped to the rooftop treated PAW storage tank via a chlorination dispenser following activated carbon adsorption. The treated water will subsequently be recycled for toilet flushing and, if necessary, plant watering. The PAW storage tank will be connected to the sewage system to drain the PAW in the event of an overflow, as well as for system maintenance (cleaning and changing the filter and carbon). When there is a lack of water in the treated storage tank, the water supply storage tank will be connected to the recirculation pipe network and used for toilet flushing.

With the help of sensors and pumps, the circulation of treated and untreated PAW would be totally automated.

It is an example of a system where the water after ablution is filtered and how the water is used. However, the system that will be used in this journal is where the water after ablution will be used one hundred percent for the use of ablution again after being filtered.

2.6 Filtering the post ablution water

This dirty water filter method is commonly used in homes, mosques, schools and places that use a lot of water. Filters are very important because they are one of the effective water savers. Nowadays, clean water supply has become one of the major issues in the world especially for developing countries. With this lack of clean water, the daily activities of the people will be affected, in turn, this will have a negative impact on the country in general [10]. Therefore, the water after ablution can also be filtered because it is not too dirty. From there the savings can be applied and the water can be reused. Because of doubt, some people refuse to use recycled ablution water for washing or ablution again becomes an obstacle in the use of recycled ablution water.

According to the fatwa of the Indonesian Ulema Council (MUI) states that recycled water is water that is processed (engineering technology) from water that has been used (musta'mal), contaminated with faeces (mutanajjis) or has changed one of its properties, such as taste, color and smell (mutaghayyir) so that it can be reused [11]. Recycled water can be used for ablution, bathing, cleaning, drinking, used for cooking and for other purposes as long as it is not harmful to health [11].

Another research found that the post ablution water can be reused. Reused water is wastewater whether water has been used (Mustaqmal water) or sewage water (Mutanajis water), then this wastewater is recycled through a distillation process that is processed and

treated [12]. This study was done by Jabatan Kemajuan Islam Malaysia (JAKIM) to determine whether the water after ablution can be used or not and found that the Shariah law sees that the use of water is allowed (halal) after recycling and the water will return to its original pure state (halal) [12].

Once the study was done showing 2 views on water after ablution can or cannot be reused have been answered. So with the existence of this study can solve the problem of public doubts about the reuse of ablution water. So with the fatwas that have been issued by organizations such as MUI and JAKIM can reduce people's concerns about recycled water and also concerns about their health.

2.7 Raspberry pi control waterflow

In this subtopic will discuss the prototype and equipment that will be used. The equipment must be appropriate so that the project to be developed achieves the objectives. The most important equipment in this project is raspberry pi. Raspberry pi is a device where humans can control electronic components for physical computing and exploring the internet of things (IoT).

Iot Based Flow Control System using Raspberry PI is an example of a project where raspberry pi is used to control the flow of water for the purpose of saving. Iot defines that an object is connected via wired and wireless networks without user intervention[13]. Figure 2.7.1.a and 2.7.1.b is shows the design of the project :

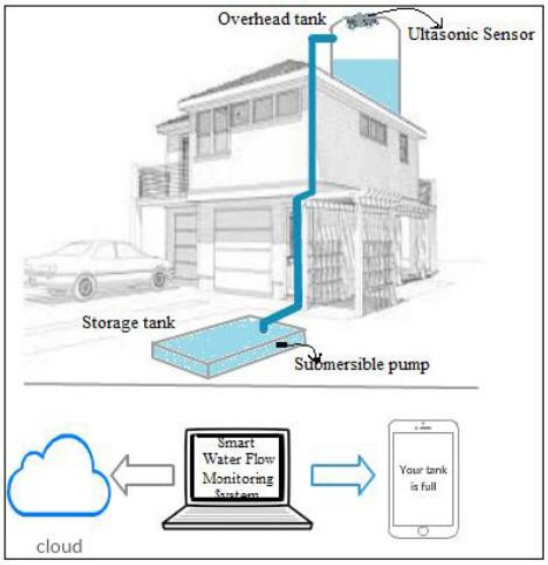


Figure 2.7.1.a : Architecture of Water Monitoring System [13]

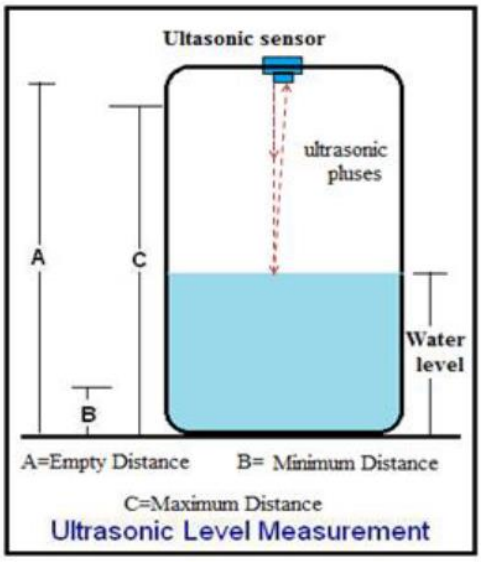


Figure 2.7.1.b : Working of ultrasonic sensor [13]

The project is based on IoT in a water distribution management system in a large area. Depending on the water level, the submersible pump will start and stop automatically. When the water level above the tank is minimizing then the submersible pump automatically starts pumping and when it reaches the maximum level the pump will stop automatically. If the water level reaches a maximum then the user will receive an SMS that the water level has reached a maximum where it will be detected to the cloud. So the system works automatically without human intervention.

Iot Based Smart Quality Water Management System is another example of project that used raspberry pi. A smart water-monitoring system is based on internet of things will make users mindful of their water consumption and help them to reduce their water usage [14]. The project is was designed to make it easier for consumers to see their daily water consumption. Figure 2.7.2 shows the proposed system [14]:

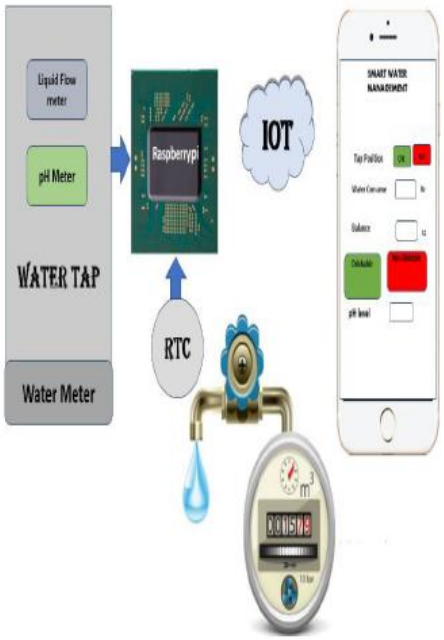


Figure 2.7.2 : Flow diagram of proposed system [14]

The diagram above shows a project design that can reduce water consumption. The main components in this project are pH sensor, water level sensor and raspberry pi. pH sensors are used for quality inspection of whether the water is suitable for use. A good pH level is essential for human well-being and it should be approximately equal to 7 [14].

Raspberry PI based liquid flow monitoring and control is another project used raspberry pi where this project about the ability to conduct accurate flow measurements is so important that it can make the difference between making a profit and taking a loss [15]. For this project if flow measurements are inaccurate or failure to take measurements can affect the results. Figure 2.7.3 is the block diagram of the proposed system to control the flow of liquid [15].

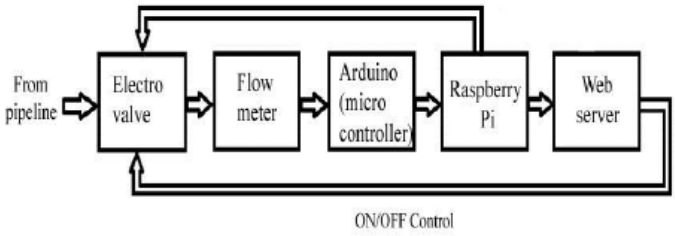


Figure 2.7.3 : Block diagram for the proposed system [15]

As the fluid flows through the flow meter, the Hall Effect sensor detects the fluid flowing and sends the corresponding data to the arduino through the interface. Next the data that has been received from the arduino will be uploaded to the raspberry pi. The Raspberry PI is a lightweight microcomputer running on this operating system that is capable of handling a wide variety of hardware interfaces. The python is used as the main coding language by raspberry pi to receive data from several serial ports [15]. The liquid flow rate will be controlled by an electro valve when the raspberry pi is activated via the internet. The electro valve is a solenoid valve and the power supply to the solenoid valve is provided via a GPIO pin from the raspberry pi and control it from a web server.

An IOT based water supply monitoring and controlling system one of the project that used raspberry pi as minicomputer that can monitor data and also control operation from cloud with efficient client server communication [16]. Water supply with constant monitoring ensures proper distribution, allowing this project to keep track of the amount available of water in tanks and flow rate. The Internet of Things is a network of physical items that are equipped with electronics, sensors, software, and network connectivity. Figure 2.7.4 is the block diagram for this project [16] :

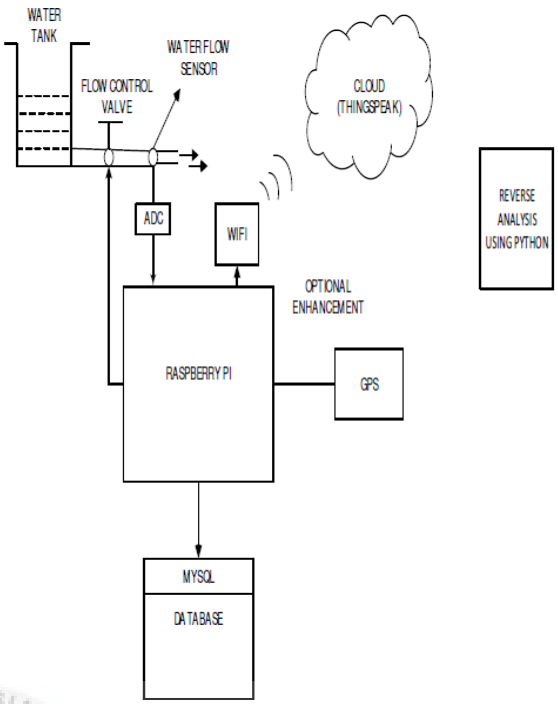


Figure 2.7.4 : Block diagram [16]

A water tank is included in the system, which is filled using a tap. The pipe connects the water flow sensor to the solenoid valve or flow control valve. The Solenoid value is controlled by the Raspberry PI by turning it on and off. If the solenoid valve is turned on by the Raspberry Pi, If the valve is set to OFF (OFF) signal sent by Raspberry Pi, water will flow through it. The water flow is stopped by the solenoid valve, and then the water flows through the water flow sensor. This sensor is a turbine that turns 3600 times for every drop of water that passes through it. It rotates 3600 times if 1 litre is passed. The turbine rotates 6400 times if 2 litres pass through the water flow sensor. The ACD unit reads the rotation valve and sends the digital value to the Raspberry Pi. The Raspberry Pi receives analogue data from the ADC unit, which it transforms to digital data.

Mobile Integrated Smart Irrigation Management and Monitoring System Using IOT is used Raspberry pi for this system to essential automated irrigation system is essential for conservation of the water and indirectly viability of the farm since it is an important

commodity [17] which mean primary agricultural product that can be bought and sold, such as coffee. Figure 2.7.5 is an example of proposed system design [17]:

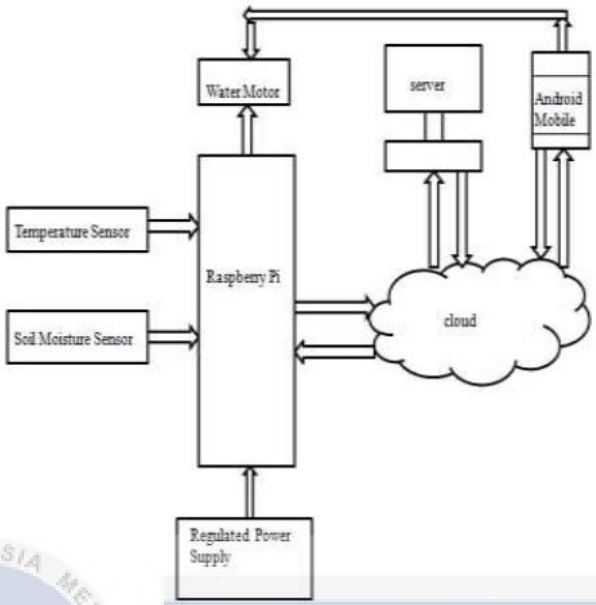


Figure 2.7.5 : System Design [17]

The raspberry pi, water pump, and moisture and temperature sensors is used in the proposed automated irrigation and monitoring system. The communication element is based on smart phones. Crops or plants are examined along with their water requirements at various stages of the proposed work. Irrigation is done according to the water requirements of the crops or plants at various stages of development. Plant moisture (water content) and temperature are measured by moisture sensors and temperature sensors. If the moisture level falls below the acceptable level, the moisture sensor sends an alert message to the Raspberry Pi, which instructs the Water Pump to switch on and give water to the appropriate plant. Also, without going to the store, you may check the motor's status and temperature on your phone.

Table 2.7.6 : Project's comparison

Project's name	Hardware	Result
1. Iot Based Flow Control System using Raspberry Pi [13]	- Raspberry pi - Arduino - Ultrasonic sensor	There have Algorithm 1 and 2 to get the result which is Algoritm 1 is for arduino to read sensor value and calculate water level. Algorithm 2 is for upload the data and sending SMS using raspberry pi.
2. Iot Based Smart Quality Water Management System [14]	- LCD -Liquid Flow Sensor - pH Sensor -Water level sensor -Raspberry pi	The data will desired at mobile application with all the information displayed on the screen. This way customer know all the details of its daily water consumption efficiently. The mobile aplication is developed by using MIT App Investor platform.
3. Raspberry PI based liquid flow monitoring and control [15]	- Raspberry pi - Arduino - Hall Effect Flow Sensor - Solenoid Electro-Valve	According to the flow meter sensor data sheet 5600 pulses = 1 litres. The program is create to send the data every second. The result can be monitored at smart phone how much water spend liter per hour.

4. An IOT based water supply monitoring and controlling system [16]	-Raspberry Pi - Flow control valve -Water flow sensor	The data are read and stored on cloud and local database that displayed on the putty terminal. As the water flow, the turbine starts to rotate. There have 3 level of water which is 50%, 75%, and 100%. This condition occurs when the water flow reaches 50%.
5. Mobile Integrated Smart Irrigation Management and Monitoring System Using IOT [17]	- Raspberry Pi -Soil Moisture Sensor -Temperature sensor	These application work totally on Bluetooth. The application Blue Term is used for coding and writing the programming instruction. This application acts like an emulator which is given as the input to the Raspberry pi. As a result, the motor will start and water will be supplied to plants.

2.8 Summary

In conclusion, this chapter 2 discusses in relation to previous research related to this project. In this chapter as well, the approaches and some methods used by other researchers in their studies are also discussed. The study made by the researcher is important information to review and differentiate the features of past research that can be a guide for the project in this journal.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The methods used to create this system by using ESP32 work as main component for this project is discussed in Chapter 3. The flow charts of the project, the software and hardware that are utilized, how the process function, and how to build and implement the project will all be detailed. The parameters were chosen based on the findings of the literature review in Chapter 2.

3.2 Methodology

This thesis presents how this project is carried out with the main component used which is ESP32. The essence of the approach used in this project focuses on the concept of ablution and reducing water wastage in the mosque. The approach chosen is based on a quantitative type, which aims to develop an analytical model to take data and analyze the amount of water required to take ablution and also aims to reduce water wastage during ablution. The design method is important for experimental purposes where the project achieves its objectives or not. Next, figure 3.2 and figure 3.3 shows the flow chart and block diagram project of this thesis.

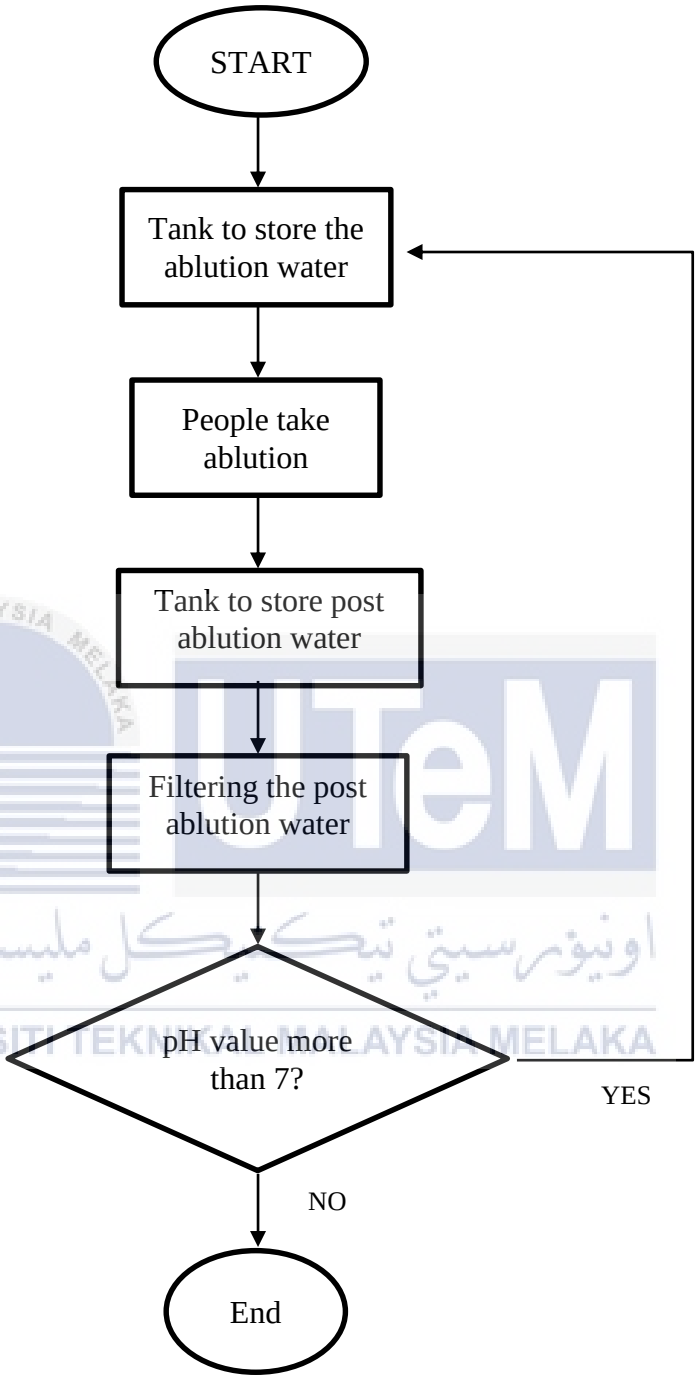


Figure 3.2.1: Flow chart project

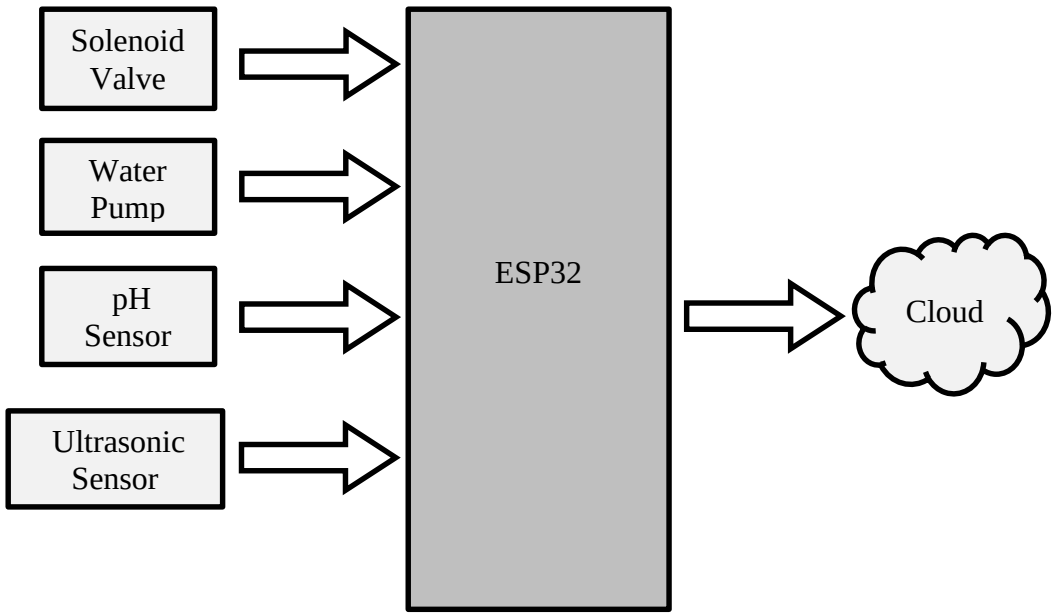


Figure 3.2.2: Block Diagram

Refer to the figure 3.2, flow chart is used to a diagram of the sequence of movements or actions of people or things involved in a complex system or activity. With a flow chart, the process for a system is easy to understand. The explanation for the flow chart of figure 3.2 is where clean water is stored in the ablution storage tank. After that, a person will take ablution for the purpose of worship and the volume of clean water in the storage tank will be reduced where the result of the ablution process runs. After a person takes ablution, the water will be channeled in the drain where it will go to the water filter for filtering process. After the filtering process, the water will be store at the clean water tank. Once ultrasonic sensor detect the level of water at the ablution water tank, the water pump will draw the water from clean water tank to ablution water tank which is the water will be pumped back to the ablution storage tank so that the water can be used and the water is completely clean and can also be reused. This process will always be repeated as long as the system is fully functional.

3.3 Experimental setup

Experimental setup for this project will be presented in this subtopic. Before creating a project, designing is very necessary to understand the concept for the project and also what hardware will be used that suits the project. Among the main hardware for this project are ESP32, ultrasonic sensor, ph sensor and water pump. With the hardware list, then the preparation to make this project will run smoothly. Autodesk eagle is the software to design the circuit before the real one be made. After designing the project by using autodesk eagle software, the experiment need to run to get the output and also to know is it the system in this project is successful. Arduino is the software used to program the coding for ESP32. Therefore, the designer of this circuit has some limitations which will be discussed in 3.6. Figure 3.1 is the design of the project.

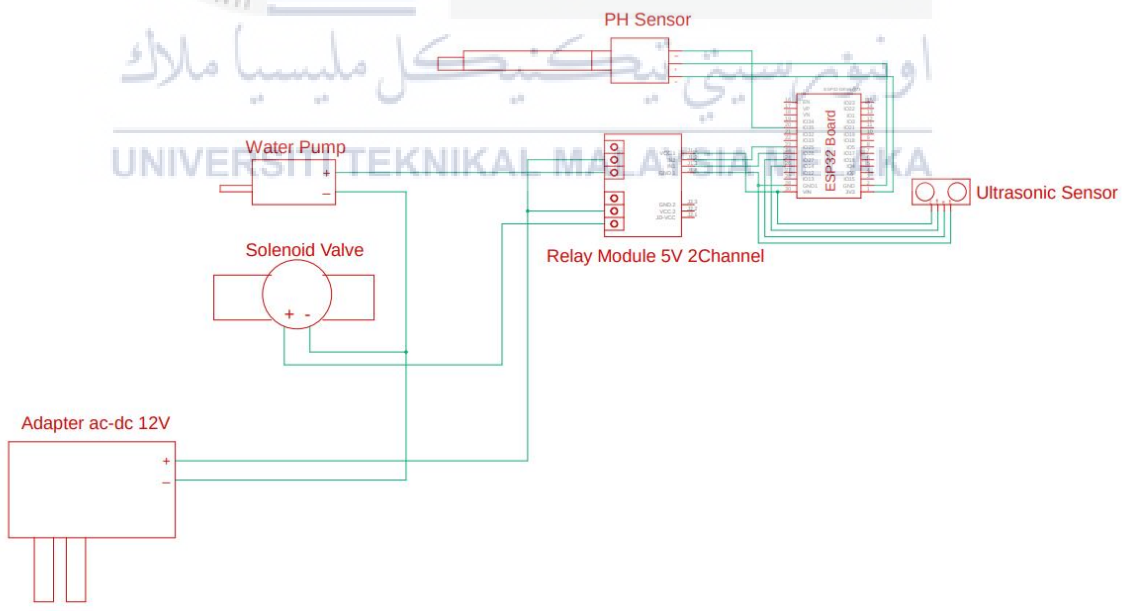


Figure 3.3.1: The circuit design of the project using autodesk eagle

3.4 Hardware and Software

Figure 3.4.1: ESP32

ESP32 can function as a full standalone system or as a slave device to a host MCU, which lessens the burden on the primary application CPU caused by communication stack overhead. Through its SPI/SDIO or I2C/UART interfaces, ESP32 may connect to other systems to provide Wi-Fi and Bluetooth capability. The ESP32 family of system on a chip microcontrollers features integrated Wi-Fi and dual-mode Bluetooth and is inexpensive and low power. The Tensilica Xtensa LX6 dual-core or single-core microprocessor, Tensilica Xtensa LX7 dual-core, or a single-core RISC-V microprocessor are used in the ESP32 series, which also has integrated antenna switches, RF baluns, power amplifiers, low-noise receive amplifiers, filters, and power-management modules.

Figure 3.4.2: Ultrasonic Sensor

The ultrasonic sensor detects the level of water and when placed in a location that has water it can send information to the user according to the type of program used. With the presence of water on the tank, the user knows how much level water is in a tank when the ultrasonic sensor detect. As an example is placed in a water tank, when the water is full then the user will know that the water in the tank still has water and likewise when the water is low the user will also be able to know.

Figure 3.4.3: pH Sensor

A pH sensor is one of the most important pieces of equipment for water testing. This sort of sensor can detect alkalinity and acidity levels in water and other liquids. PH sensors, when utilized correctly, may ensure the safety and quality of a product as well as the processes that take place within a wastewater. The standard pH scale is usually represented by a number that ranges from 0 to 14. A material is termed neutral when it has a pH value of seven. A pH value more than seven indicates a higher level of alkalinity, whereas a pH value less than seven indicates that the substance is more acidic.

Figure 3.4.4: Water Pump

A water pump is a machine that transports, compresses, or moves water. Pumps come in a variety of shapes and sizes, including gear pumps, peristaltic pumps, gravity pumps, and impulse pumps. All of them are applicable to a variety of industries. The water pump is the most often utilised type of pump in everyday life. Water pumps are used for a variety of tasks in the home, light commercial, and agricultural sectors. It can be extremely beneficial, particularly in rural areas. A water pump can drain and fill a swimming pool or dam, as well as drain and fill a basement or shallow flooded area. It can also be used in agriculture to provide irrigation.

Figure 3.4.5: Solenoid Valve

Solenoid valves are used for fluid flow but they are used automatically. These solenoid valves should be pre -programmed according to the objectives of a project. With this solenoid valve, it can be easier for users to use it without making the fluid flow manually. The solenoid valve allows the fluid to flow according to the user's specifications.

Figure 3.4.6: Arduino Software

Arduino software is a programming language that is commonly used to create websites and applications, automate operations, and perform data analysis. Arduino software is a general-purpose programming language, which means it can be used to develop a wide range of applications and isn't tailored to any particular problem. Because of its versatility and beginner-friendliness, it has become one of the most widely used programming languages today.

Figure 3.4.7: Blynk application

This framework makes it easy for Arduino programmers to develop GUI elements using the Blynk toolkit's widgets. In a Arduino application, Blynk widgets can be used to create buttons, menus, data fields, and many more. These graphical elements can be linked to or interact with features, functionality, methods, data, and even other widgets once they've been developed. A solenoid valve, for example, can be turned on or off to control the flow of

water and can also be programmed to perform a specific activity, such as departing the application.

3.5 Design Project Prototype

Design project prototype is a description of a project where the flow of the system is shown in more detail. With the prototype design of this project, it is easier to understand. Figure 3.7 is the design of the project which is included the hardware that will be used.

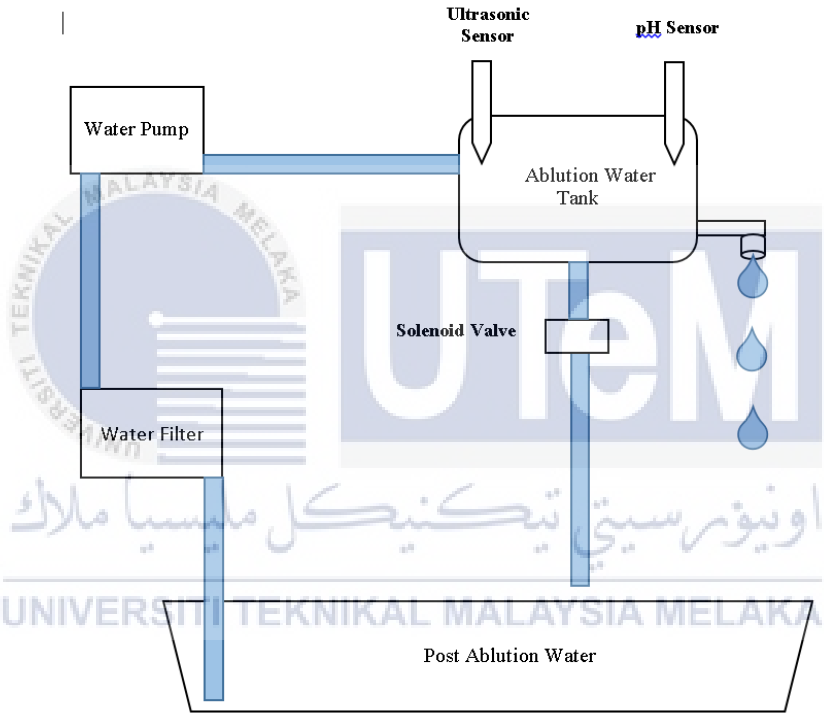


Figure 3.5.1 : Project Prototype Design

Ablution water tank will store clean water according to the volume of a tank. In the ablution water tank there is a ultrasonic sensor and also a pH sensor. Ultrasonic sensor serves to measure water level while pH sensor detects alkalinity and acidity levels in water. When a person takes ablution the post ablution water will flow directly into the water filter and it will be channeled to clean water tank after filter. As soon as the water in the ablution water tank decreases that detected by ultrasonic sensor, the water pump will start working which

is it will draw the water from clean water tank after filter to the ablution water tank. However, when the ablution water tank had some issues in quality of water, the ph sensor will detect the alkalinity and acidity water. When the water in ablution water tank contaminated, the solenoid valve will open to make the water flow to the filter for the filtering process. The water pump also plays an important role in putting pressure on the water to rise to the ablution water tank. After that, the water will be filtered and pumped back to the ablution water tank until the ultrasonic sensor detects the volume of water then the water pump will stop. Solenoid valve close as well until ph sensor detect the water is not contaminated.

3.6 Limitation of proposed methodology

Each system or project designed must have the limitation of proposed methodology. Limitation of proposed methodology is a design feature or methodology that affects a system or project to be designed. For this project, one of the limitations is that the price for the hardware is very expensive. Expensive prices are one of the limitations where designers need sufficient funds or financial resources before designing a project. If one of the hardware is not purchased then it will affect the project. Although the project is fully completed, half of the hardware such as ESP32 that uses IoT requires strong internet access so that the data sent to users can be viewed properly. In addition, running out of stock is also a limitation for this methodology because it takes time for the project to be completed. As the designer has set a time period to complete the project but the hardware to be purchased is out of stock and will slow down the project completion process. The pH sensor reading is not accurately, this can effect the value of alkalinity and acidity of water. So from that if the pH sensor is not accurately it also effect the solenoid valve which is it will open to make the water at ablution water tank go to the water filter eventhough the water is still clean. So with that, this system still has limitations where some equipment does not get accurate data for monitoring

purposes. Lastly, The water pump also has a limitation where the delay used is 1 second, the water pump cannot always move when drawing water because it will cause the ESP32 to heat up and can damage the controller.

3.7 Summary

In conclusion, chapter 3 discusses the methodology that includes the project flow chart, as well as the software and hardware used for the purpose of creating this project. At the same time, the results of all these methodology discussions facilitate understanding as to how the process works, as well as how to plan and execute projects properly.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and analysis for this project. As described in chapter 3 regarding the methodology of how the project was produced once the hardware had been described, the results and analysis need to be made. With the results taken by the data as it has been programmed get the desired results. Therefore, the results are very necessary to know whether the results will be the same when the project is fully completed.

4.2 Results and Analysis

Result and analysis will be made in this chapter after all designs and prototypes have been designed as discussed in chapter 3. The data taken needs to be more careful to get an accurate and correct analysis without any mistakes that can make this product doubtful. Data and analysis will be shown after the description related to the prototype. Figure 4.2.1 below is the design that has been designed and all components and hardware have been connected according to the proposed of this project. The picture below will show the type of sensor, motor and filter used in the prototype. After that, an explanation related to how this project works will be explained after the prototype picture is shown.

Figure 4.2.1: Prototype design

Figure 4.2.2 is the design proposed in chapter 3. Thus, all the hardware and components proposed in the methodology have been completed on the prototype. The picture will show the labels for the components and hardware used.

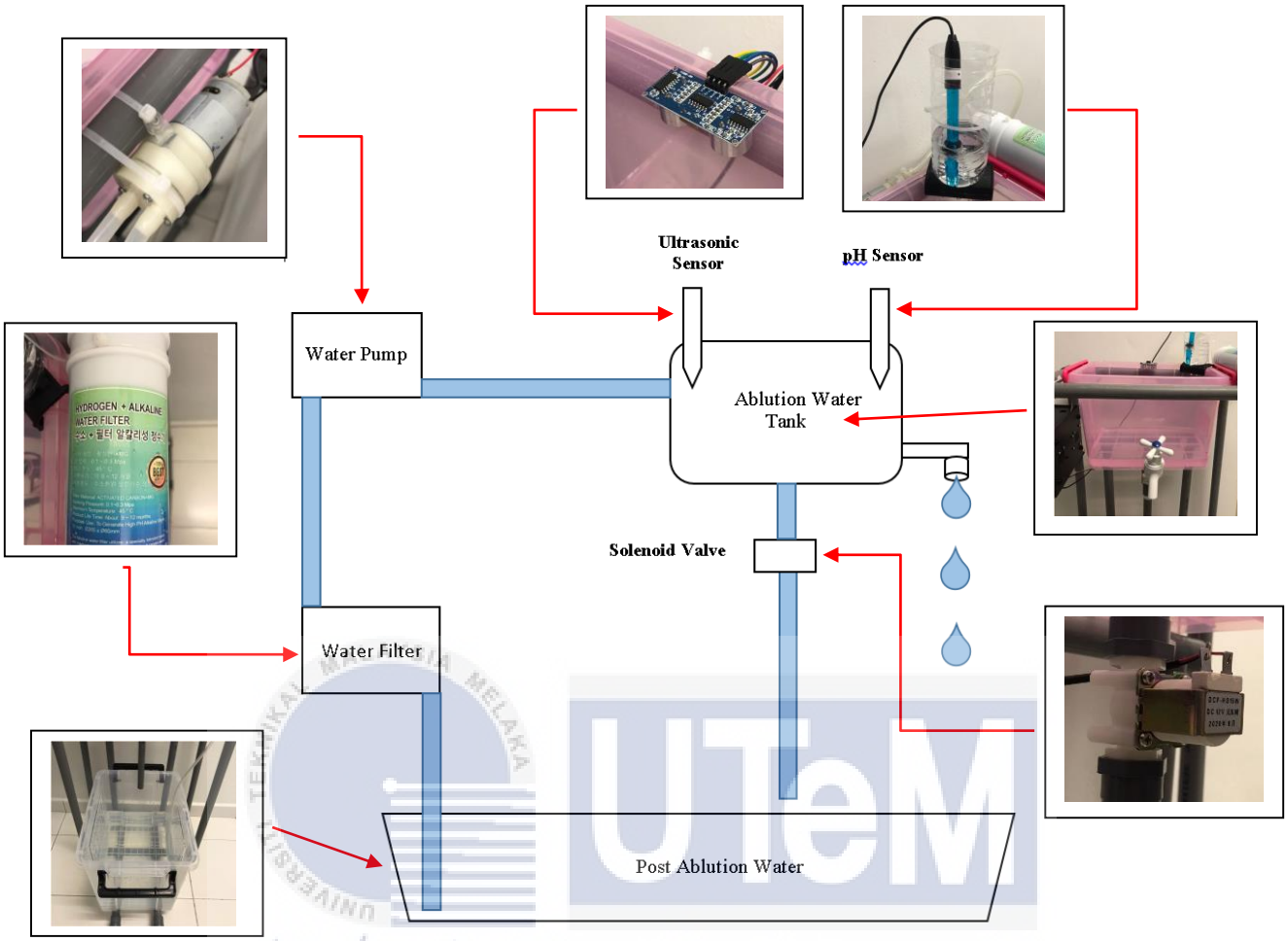


Figure 4.2.2: The proposed design is complete with component and hardware

For this system, when the water is full, the ultrasonic will send data to esp32 to be processed before being sent to the user. Likewise with ph sensor, it is processed first by esp32. Once processed, the data will be sent to the user and the user can view the data using the blynk application. The internet connection needs to be connected first between the user's esp32 and icloud so that the data can sent continuously.

For the water pump condition, when the pipe is opened by the user to take ablution, the ultrasonic will detect the reduction of water in the tank where the ultrasonic detects the distance of the water, but the distance is not suitable for use in this method. So using the volume of water in the tank is better to monitor the amount of water in the tank. While the water after ablution will be stored in the post ablution tank. For the main tank, the set volume is 6.5 liters. When the water in the tank decreases due to the use of water during ablution, it will reach a point where the tank only has a volume of 1 liter, then the water pump will start moving to draw water to the main tank. But the water will be filtered first. The water pump will always be on until the volume of water reaches 6.5liters and then it will off automaticly. So the process will repeat continuously every time the water decreases when the user takes ablution..

As for the valve, the pH sensor plays the role of turning on the valve when the pH water is less than 7 or more than 9.5. This is to prevent users from using poor quality water when performing ablution. So the valve will be opened to dump the water into the post ablution tank. However, the use of filters is rarely problematic because the durability of filters can reach 6-12 months. In case if the pH detects the impurity of the water less than 7 then the main problem is in the filter and should be immediately changed to a new one, so the pH sensor plays an important role to notify the user related to the impurity of the water in the main tank.

4.3 Analysis for the project condition

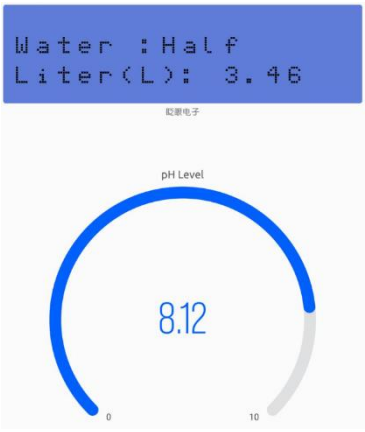
There are 4 conditions below where the results shown are the output for this project included with the output in blynk. So the user can know the status of this project whether it is in good condition or not and whether the system is running well even if the user is not in the area.

Table 4.3.1: Full water in ablution water tank (Initial condition)

Data	Result
	Water Level= Full Volume water = 6.42liters pH Value = 8.15 Water pump = Off Valve = Off

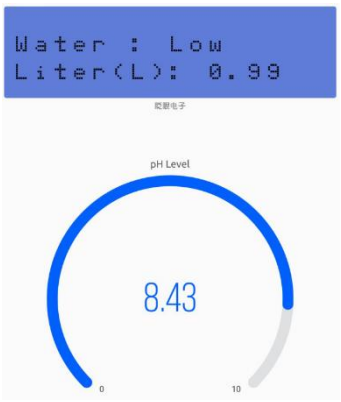
Table 4.3.1 is the initial condition where the water in the tank is full and the full volume for the tank is 6.42 liters. pH value is more than 7 where the water has good quality. Water pump is off because the water level is still full. Valve also off because the value of pH is still in good condition which is 8.15.

Table 4.3.2: User use for ablution

Data	Result
	Water Level= Half Volume water = 3.46liters Ph Value = 7.61 Water pump = off Solenoid Valve = off

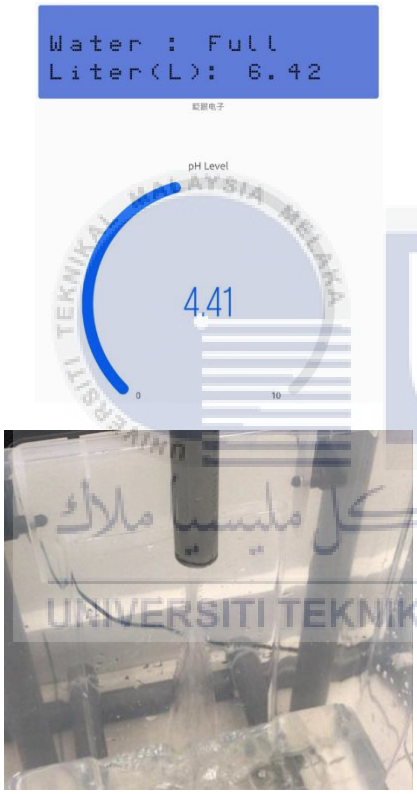
For table 4.3.2, once this system is used the water reduction will occur. There the ultrasonic will detect the amount of water reduction and the decrease in water volume will also be reduced to 3.46 liters. Water pump still off because the water level is in half condition and valve also off due to value ph is in good quality.

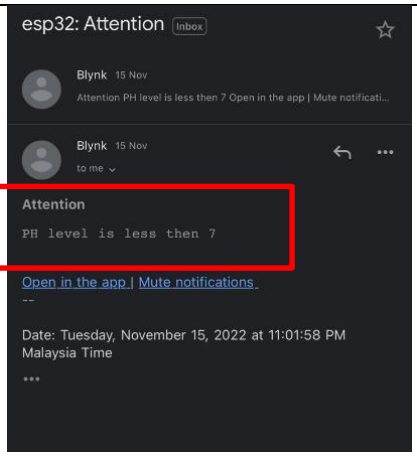
Table 4.3.3: Water level in main tank low

Data	Result
	Water Level= Low Volume water = 0.99liters Ph Value = 7.93 Water pump = On Solenoid valve = Off

For table 4.3.3, after using this system many times, there will come a point where the water is in a low state (low level= 0.99liters). So the water pump will move to draw dirty water to be filtered first and will be put into the main tank until it reach 6.42liters then the water pump will stop

Table 4.3.4: pH sensor detect value below 7

Data	Result
	Water Level= Full Volume water = 6.42liters pH Value = 4.41 Water pump = Off Solenoid Valve = On -Once the pH value less than 7, the system will send notification to the user's email.

For the condition in table 4.3.4, this condition is related to water quality where the pH sensor will determine the water quality after the water is full in the main tank. The solenoid valve will start to trigger when the water is full and the pH reading is less than 7. In the table above the total pH is 4.41 which is bad quality, then the solenoid valve will open and remove all the dirty water in the main tank.

4.4 Analysis for the water consumption for a day

Figure 4.4.1: The tank used to collect user's data during ablution

For figure 4.4.1 is the tank that will be used to take ablution because it requires a large volume of water in the tank to cover the use of ablution water for a day. The volume for this tank is 30liters which is the width=40cm, length=25cm, height=30cm. The analysis for water consumption for different days where the 3 users will be taken data for the use of water during ablution. The purpose is to analyze the volume of water used by each person when performing ablution.

Table 4.4.1: User's 1 (Monday 9/1/2023)

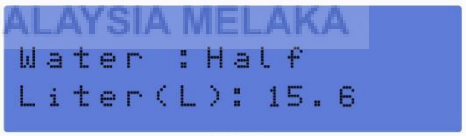
Description: User's 1 will use this system to take ablution for performing 5 times prayer for a day.	
Prayer: Subuh Volume(l): 30.42-26.40 : 4.02	
Prayer: Zohor Volume(l): 26.40-21.3 : 5.1	
Prayer: Asar Volume(l): 21.3-15.6 : 5.7	
Prayer: Maghrib Volume(l): 15.6-11.1 : 4.5	
Prayer: Isyak Volume(l): 11.1-7.2 : 3.9	

Table 4.4.2: User's 2 (Tuesday 10/1/2023)

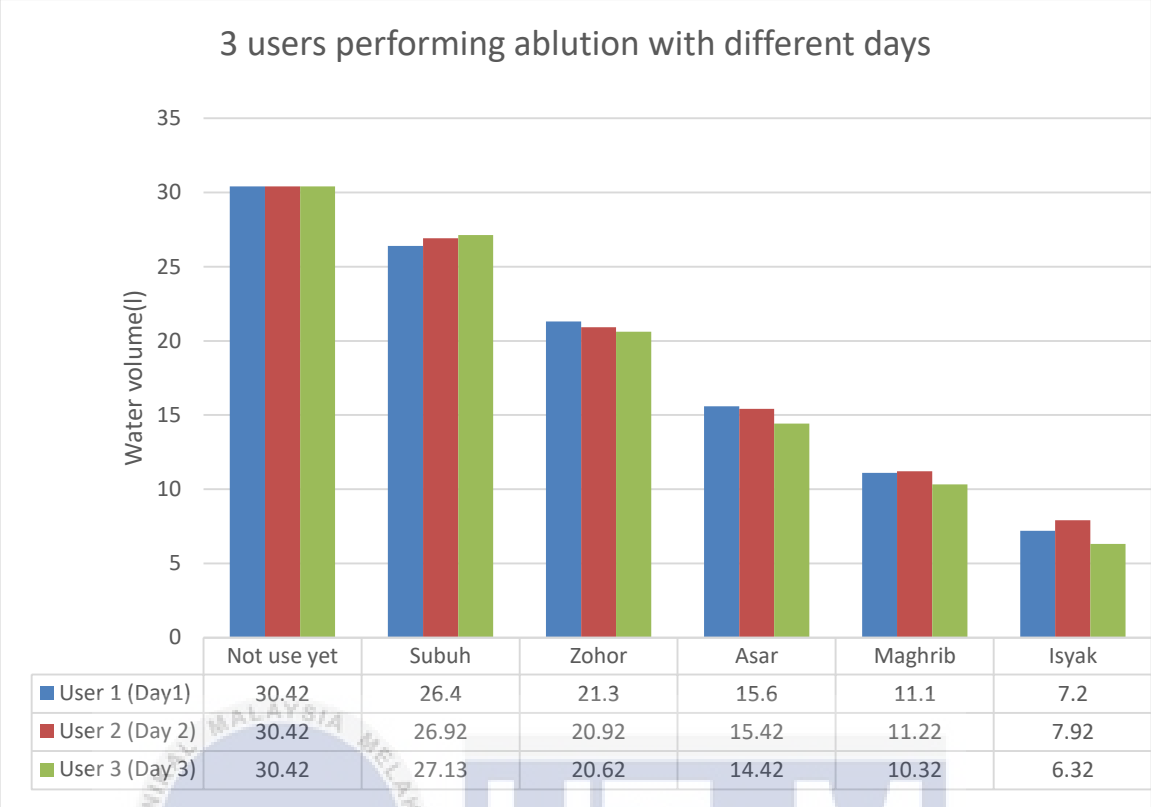
Description: User's 2 will use this system to take ablution for performing 5 times prayer for a day.	
Prayer: Subuh Volume(l): 30.42-26.92 : 3.5	
Prayer: Zohor Volume(l): 26.92-20.92 : 6	
Prayer: Asar Volume(l): 20.92-15.42 : 5.5	
Prayer: Maghrib Volume(l): 15.42-11.22 : 4.2	
Prayer: Isyak Volume(l): 11.22-7.92 : 3.3	

Table 4.4.3: User's 3 (Wednesday 11/1/2023)

Description: User's 3 will use this system to take ablution for performing 5 times prayer for a day.	
Prayer: Subuh Volume(l): 30.42-27.13 : 3.29	
Prayer: Zohor Volume(l): 27.13-20.62 : 6.51	
Prayer: Asar Volume(l): 20.62-14.42 : 6.2	
Prayer: Maghrib Volume(l): 14.42-10.32 : 4.1	
Prayer: Isyak Volume(l): 10.32-6.32 : 4	

Table 4.4.4: Water consumption for 3 users when performing 5 times prayer for a day.

User	Subuh	Zohor	Asar	Maghrib	Isyak	Total volume(liters) per user for a day
1	4.02	5.1	5.7	4.5	3.9	23.22
2	3.5	6	5.5	4.2	3.3	22.5
3	3.29	6.51	6.2	4.1	4	24.1



	Not use yet	Subuh	Zohor	Asar	Maghrib	Isyak
User 1 (Day1)	30.42	26.4	21.3	15.6	11.1	7.2
User 2 (Day 2)	30.42	26.92	20.92	15.42	11.22	7.92
User 3 (Day 3)	30.42	27.13	20.62	14.42	10.32	6.32

Figure 4.2.2: Water usage during ablution for 5 times prayer

4.5 Testing pH using vinegar.

Figure 4.5.1: Vinegar will be used to lower the pH value

Figure 4.5.2: The pH value once the vinegar poured in the water

For the pH sensor, vinegar will be used for testing as in figure 4.5.1 and vinegar can also reduce the pH value as in figure 4.5.2 once the vinegar poured in the water. The reason using vinegar is because the acidity of vinegar is below than 7 just like human sweat. Human sweat is in the category of acidity 4-5 ph. So when people take ablution then the water is contaminated with their sweat.

Figure 4.5.3: Channels that will dispose of dirty water

In figure 4.5.3, that is the channels that will dispose of dirty water in the main tank once pH sensor detect value below 7 and the valve will open. As for the filter, Hydrogen + Alkaline filter is used to neutralize water after it is contaminated with human sweat. However, the total pH after filtering is in the range of 7-9.5 ph. This filter will increase the pH to 8.5-9.5 and it provides some benefits to human health.

4.6 Water cleanliness (pH value) after 5 time refilled.

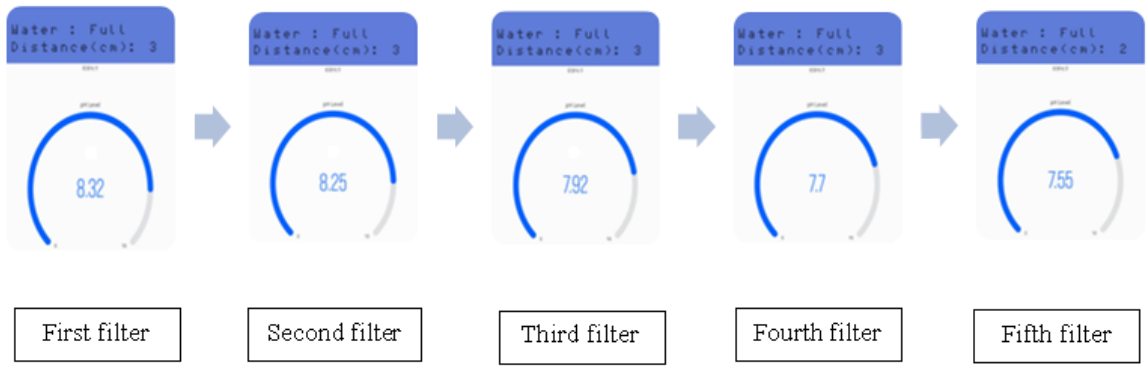


Figure 4.6.1: pH value after 5 time refilled.

Figure 4.6.1 is a process where the use of water is filtered 5 times when the main tank lack of water. Referring to water quality, the pH is in the range of 7-9 where it is safe to use. Testing is done using vinegar because the acidity of vinegar is below 7. Referring to water quality, the pH is in the range of 7-9 where it is safe to use.

4.7 Summary

In conclusion, this chapter discusses the analysis and results obtained. Referring to chapter 3 related to methodology, where all the components discussed there have been used and built in this chapter 4. As a result of the installation of the project prototype, it was successfully designed according to the requirements discussed in chapter 3. Not forgetting also the correct installation of the circuit is also a factor in the success of the analysis and the results obtained. Therefore, there are 3 types of decisions taken to make the analysis. Project condition, water consumption for a day and total water cleanliness (pH value) after 5 times refilled. After all the analysis has been done, the conclusion is that this product can be used safely and can reduce water wastage in mosques or suraus.

CHAPTER 5

CONCLUSION

5.1 Conclusion

In conclusion, this research aims to reduce water consumption in the mosque, as highlighted in Chapters 1, 2 and 3. Based on the findings of Chapters 3, 4, and 5, this chapter explained conclusions. Following the sequence of the three study objectives described in section 1.3 of Chapter 1, the conclusion is based around a discussion of the key research objectives. The conclusion chapter also discusses the research findings' recommendations, their addition to knowledge in this field, and the study's shortcomings. This chapter concludes with research recommendations.

In the study that has been analyzed, every mosque needs enough water for the purpose of ablution, so the amount of water used by a person to take ablution has been surveyed and made a study in other people's research where 5-9 liters are used by a person to take one ablution. Apart from that, with this project, it is possible to develop a system that can reduce water waste during ablution. Even with this system, the use of post ablution water can be reused after being filtered.

The methods and applications of ablution water recycling have been carefully studied where the post ablution water can be reused after being filtered. So with research on this recycled water, it can remove the doubts of people to use water that has been filtered from the post ablution water. Finally, the research made and sought has been carefully studied to complete this thesis.

Chapter 4 is a design produced according to the methodology in chapter 3 as proposed. After that testing is done whether the product achieves the objective or not. After being tested, the product was successfully produced according to the proposed standards. After that, the data on the product will be taken for analysis. Finally, all the data and analysis studied have achieved the objectives that have been set.

After everything is completed, it is proven that this product is very useful in mosques or suraus to save water use in the area. The consumption and quality of water is very important in that place because waste of water should be avoided and this can save bills in areas that use this product.

However, this product needs to be improved where the recycled water other than post ablution water such as water from mosque cleaning, water from sink and water from toilet pipes. The recycle water can used for other purposes besides ablution such as for plants, for mosque cleaning or for toilet. Potential commercial for this product is it can use at mosque and surau around Malaysia because water wastage happen every day in the mosque and surau.

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APPENDICES

Gantt Chart for PSM 1

WEEKS	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
Activities														
PSM 1 Briefing with SV														
Start searching journal														
Progress Work 1														
Project Research														
Research on literature review														
Report Preparation														
Progress Work 2														
PSM 1 Report Submission														
PSM 1 Presentation														