THE DEVELOPMENT OF ONLINE MONITORING SYSTEM FOR WATER CONSUMPTION IN ABLUTION ACTIVITY CONSIDERING MALAYSIAN CULTURAL PREFERENCES

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BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PROCESS AND TECHNOLOGY) WITH HONOURS

2022

Faculty of Mechanical and Manufacturing Engineering Technology

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in fulfillment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

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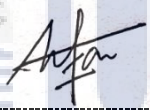
2022

DECLARATION

I declare that this Choose an item. entitled " The Development of Online Monitoring System for Water Consumption in Ablution Activity Considering Malaysian Cultural Preferences" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours.

Signature : 

Supervisor Name : Dr. Ihwan Ghazali

Date : 18 January 2022

DEDICATION

Alhamdulillah, my gratitude to Almighty Allah for enabling me to successfully completed this thesis. My gratitude and appreciation to all people who were always supported me to perform this report well truly from family. And finally, many thanks to my supervisor Dr Ihwan Ghazali, who were give effort, support and advice that guiding me also not forget for his chance that give me the title for final year project feel better to performed the progress. Thank you also for all my fellow friends who always support and encourage me.

ABSTRACT

Water is an important resource for life and its existence and, unfortunately, large quantities of water are being wasted on daily basis especially on ablution ritual at mosques which is consumes large amount of water. Monitoring the consumption of water can control water usage, and smart technologies can play a useful role. In this paper, a smart system based on Internet of Things (IoT) has been proposed to monitor the water consumption in ablution considering Malaysia is country of many Islamic people. A water flow sensor, together with Arduino, continuously monitors the water that used and sends these data to a server through a Wi-Fi module. Using the data collected from the culture in Malaysia to find the preferences of the atributes of characteristic of online water monitoring with IoT system. The water can be monitor in real time the help of IoT system. The water consumption is predicted for each day for the user. An algorithm to monitor the flow of water consumption and can be used to detect leakage of water in the tanks has also been proposed. A web interface allows the user to visualize the water usage, monitor their consumption, and detect any leakage and leakage rate in the system through smartphone and laptop.

ABSTRAK

Air merupakan sumber penting untuk kehidupan dan kewujudannya dan, malangnya, air dalam kuantiti yang banyak dibazirkan setiap hari terutamanya pada ibadah wuduk di masjid yang mengambil banyak air. Memantau penggunaan air boleh mengawal penggunaan air, dan teknologi pintar boleh memainkan peranan yang berguna. Dalam kertas kerja ini, sistem pintar berasaskan Internet of Things (IoT) telah dicadangkan untuk memantau penggunaan air dalam wuduk memandangkan Malaysia adalah negara yang mempunyai ramai umat Islam. Sensor aliran air, bersama-sama dengan Arduino, memantau air yang digunakan secara berterusan dan menghantar data ini ke pelayan melalui modul Wi-Fi. Menggunakan data yang dikumpul daripada budaya di Malaysia untuk mencari keutamaan atribut ciri pemantauan air dalam talian dengan sistem IoT. Air boleh dipantau dalam masa nyata dengan bantuan sistem IoT. Penggunaan air diramalkan untuk setiap hari untuk pengguna. Algoritma untuk memantau aliran penggunaan air dan boleh digunakan untuk mengesan kebocoran air dalam tangki juga telah dicadangkan. Antara muka web membolehkan pengguna menggambarkan penggunaan air, memantau penggunaan mereka, dan mengesan sebarang kebocoran dan kadar kebocoran dalam sistem melalui telefon pintar dan komputer riba.

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LIST OF SYMBOLS AND ABBREVIATIONS

IoT	-	Internet of Things
MIT	-	Massachusetts Institute of Technology
RFID	-	Radio Frequency Identification
GPS	-	Global positioning system
IBM	-	International Business Machines Corporation
PIC	-	Programmable Intelligent Computer
LED	-	Light-Emitting Diode
GUI	-	Graphical User Interface
VUI	-	Vector Distance Algorithm
PAA	-	Polygon Area Algorithm
ARM	-	Advanced Risc Machines
RF	-	Radio-Frequency
ADC	-	Analog Digital Converter
LCD	-	Liquid Crystal Display
GSM	-	Global System Mobile
SMS	-	Short Message Service
DC	-	Direct Current
OLED	-	Organic Light-Emitting Diode
IDE	-	Integrated Development Environment
MATLAB	-	Matrix Laboratory
PLS	-	Partial Least Squares
CFA	-	Confirmatory Factor Analysis
CR	-	Composite Realibility
AVE	-	Average Variance Extracted
HTMT	-	Heterotrait-Monotrait Ratio
VIF	-	Varience Infation Factor
HCM	-	Higher-Order Model / Hierarchical Component Model

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CHAPTER 1

INTRODUCTION

1.1 Background

There have been nearly 19.5 million Muslim believers in 2013, accounting for 61.3 percent of the total population which defining Islam as the most widely professed religion in Malaysia. Meanwhile, the population of other religions which are Buddhism (19.8%), Christianity (9.2%), and Hinduism were among the other religions practiced (6.3%) approximately (Department of Statistics Malaysia, 2020). In defining the cultural preference towards Muslim population, it can be stated that culture has a significant impact on certain facets of how an individual thinks, acts, and acts in various situations which most profoundly, one's culture influences the very essence of the "self" that is thought, experiencing, and acting (Wilken, Miyamoto, and Uchida 2011). Besides, religion is described as a cohesive set of beliefs and practices that pervades a society's value structure and, as a result, forms a core part of a country's cognitive or ideological elements in its cultural background. In Malaysia, Islam had the wide influence in determining people's behavior, practically among Muslim that need to follow the obligations in Islam. For example, it is a compulsory for a Muslim in performing prayer at 5 set times of day and other activities that involved in water consumption during the process of practices.

While prayers can be performed anywhere on earth that is clean and pure, the mosque is important for communal prayer because it is the main religious building reserved for Allah's worship and typically has one or more minarets (Ebrahimi and Yusoff 2018). According to the individual's view, this will decide whether a Muslim can worship at home or in a place of worship. However, if there are no barriers that might affect the environment or public health,

certain rituals, such as Friday prayers, must be held in the mosque. Based on previous research by (Wilken, Miyamoto, and Uchida 2011), he has been discovered that people value expressing themselves through their preferences and desires differently depending on their cultural background and the level of beliefs on their religion.

For Muslims, the practice of ablution, or called as Wudhu, is a regular Islamic procedure that is repeated many times before performing the prayers or certain other activities such as reading the Al – Quran. Based on the previous research by (Mohd Aiman bin Mohd Fauzi, Jaanavee Devi a/p Sundaresan, and Abidin 2020), the ritual of ablution, which entails washing specific parts of the body with clean water, is a mandatory ritual for any Muslim before performing regular prayers. In general, ablution is accompanied by washing on a specific body part, with the washing ritual including the washing of the face, both hands, the forehead to the crown of the head, and both feet (Johari et al. 2013a). Due to this situation, the amount of water required is estimated less than 1L by per person. Besides, (Yusof et al. 2020) mentioned that the average Muslim uses 5L of water for ablution, but it is suggested that a Muslim needs up to 25L of filtered raw water for ablution and during Friday prayer will caused the amount of water consumption will be doubled. By using a manual closing tap water, the amount of water consumption during ablution could be determine based on the observation which is the period from when the water pipe is opened to when the process is completed without consumer awareness.

Therefore, the water monitoring project is to measure the flow rate and monitoring the water of water supply and give the notification to user about the water that had been used in ablution. The Arduino is acts as a main microcontroller to control all activity in circuit. The input of this project is a flow sensor that sensed the flow rate in water. This information is sent to microcontroller to analyze the water flow when is used. When the sensor detects the water flow, the Arduino give a signal to Internet of Things (IoT) and send the information into the cloud based. Then the user can monitor the flow rate of water in website with phone or laptop

to know the amount of water that flow out from the pipe. So, the users are able to predict the cost and consumption of water and also this system can be used to detect any leakage from the tank.

1.2 Problem Statement

Since ablution ritual at mosque are more used amount of water. The old traditional faucet is commonly used for water dispensed from the tank which is lead more waste since people not using it efficiently. As for the monitoring system is by manually which is read the stat of water consuming by the flow meter from the main pipe. To tackle this problem, a smart system based on IoT is required to track how much water is being consumed in real time. Water usage is continuously monitored and data is delivered to a server using a water flow sensor and Arduino. The data is gathered by the IoT system, and the real time usage comsumption can be determined. It can also be used to detect water leaks in the tank as an alternative.

1.3 Research Objective

The aim of this research is to design water flow device using IoT system for ablution considering the cultural in Malaysia. Specifically, the main objective of this study is to focus on the aspects indicated below:

a. To achieve any the attribute water monitoring using IoT system for ablution.
b. To design a system that monitor the water consumption using IoT based on cultural influences in Malaysia.
c. To develop prototype of water monitoring system.

1.4 Scope of Research

The scope of this research are as follows:

a. The study is conducted on how the water is being monitor in mosque in Malaysia.
b. The flow water sensor and Arduino are used in this project, which continuously monitors the amount of water used and communicates the data to a server via a Wi-Fi module.
c. The effectiveness of water monitoring will be evaluated in a real-world setting.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will explain about literature review that related to this study. The literature review is based on the theoretical framework which is to find the impact of. It first addresses the overview of Internet of Things (IoT) relevance in the water industry, and then the researchers amplify the significance of cultural preference in Malaysia. This chapter also present summary of previous research about the development of online monitoring system for water consumption in ablution activity considering Malaysian cultural preferences. Thus, it is devoted to exploring consumer's motivation on Hofstede's Cultural Dimension theory and ultimately leads to the hypotheses. A product development based of customer requirement need a depth research by analyzing the previous case study. Besides that, product development using Internet of Things (IoT) as base for producing the product based on the culture in Malaysia.

2.2 Introduction Internet of Things (IoT)

The Internet of Things (IoT) is a vision in which the Internet extends into the real world, It represents a concept in which the Internet spreads into the actual world, engulfing everyday items and people with software. The Internet of Things (IoT) is a new network architecture that uses software to connect physical resources and people (Kramp, van Kranenburg, and Lange 2013). The Auto-ID Center at the Massachusetts Institute of Technology (MIT), which began designing and propagating a cross-company RFID infrastructure in 1999, popularised the phrase Internet of Things (IoT). The Internet of Things (IoT) is a self-configuring dynamic global network architecture with standards and

interoperable communication protocols that allows physical "things" to be effortlessly incorporated into the information infrastructure. The goal of the Internet of Things is to establish an environment where fundamental data from any networked object may be efficiently shared with others in real time. Such an approach is promising and capable of supporting advanced decision support systems by offering services in a more accurate, detailed, and intelligent manner, thanks to its more powerful and efficient data collection and sharing ability.

The fundamental characteristics of what the Internet of Things technology does were summarised in the previous work as follows: the Internet of Things is a global and real-time solution where the IoT technology is Internet-based or other wide-area network-based, and the scope of the IoT has no physical boundary. The Internet of Things can include any object that is connected to the internet. Furthermore, data communication across the Internet of Things is constrained by time and can be classified as real-time or near real-time. It is mostly wireless and capable of providing detailed information about their surroundings in both indoor and outdoor settings. For connecting with the physical world, wireless sensor networks (WSN) or RFID are used, and data collection is frequently done wirelessly (REF). This feature greatly enhances the information's richness. It provides the capacity to monitor environments remotely and trace or track items. RFID sensor networks provide the ability of wireless, real-time monitoring and tracking of any tagged objects in an indoor or outdoor environment to provide complete visibility of the resources by combining the use of RFID sensor networks with other technologies such as global positioning system (GPS) or infrared sensor detection.

2.3 Malaysian Cultural Preference Muslim population in Malaysia

2.3.1 Overview of Cultural Preference Theoretical Calculations of Feeders

According to White (2013) (White 2013), the word of culture itself came from the Latin term culture has a clear history, since it is derived from the verb colo (infinitive colere),

which means "to tend," "to cultivate," and "to till," among other things. Thus, culture is a set of regular ways of thinking, feeling, and behaving that are acquired and transmitted mostly through symbols, and that characterise the distinctive achievements of human groups, including their representations in artefacts.: Traditional (i.e. historically generated and chosen) ideas, as well as their associated value, form the basic core of culture (Fuentes 2019). Culture also can be defined as a common system of information, beliefs, processes, attitudes, and artefacts within a community. It is certain that the cultures in which we interact have a significant impact on our actions (Gill 2013). In other words, culture refers to the way people communicate with each other and, a set of ideas and behaviors that everyone must adhere to in order to be considered a part of society. In the next subsection, the dimensions of culture will be discussed respectively according each of dimension in Hofstede (1980).

2.3.2 Cultural Dimension

The cultural value dimensions assist individuals or groups in comprehending and making sense of culture. These aspects provide people a particular viewpoint on culture including the view of how everyone understand their own culture. Besides, cultural dimensions also indicate how different cultural groups are discovered to be in terms of psychological characteristics such as values, beliefs, self-concepts, attitude, and actions in empirical studies. Thus, this study examines Hofstede's (1980) cultural dimensions theory, which finds overarching cultural practices or dimensions that have a major impact on human actions.

Hofstede (1980) gathered information from International Business Machines Corporation (IBM), a huge international company, and evaluated information from 40 various nations. He came to the conclusion that “organizations are culturally bound” based on his quantitative statistical analysis (Crèvecoeur-MacPhail et al. 2010). Power distance, uncertainty avoidance, individualism, masculinity, long-term orientation, and indulgence are

the six dimensions that currently make up Hofstede's framework. (Agodzo 2014). In Figure 2.6, Hofstede's five cultural dimensions are represented, and explanations of each dimension are provided. In Figure 2.1, Hofstede's five cultural dimensions are represented, and explanations of each dimension are provided in the next subtopic.

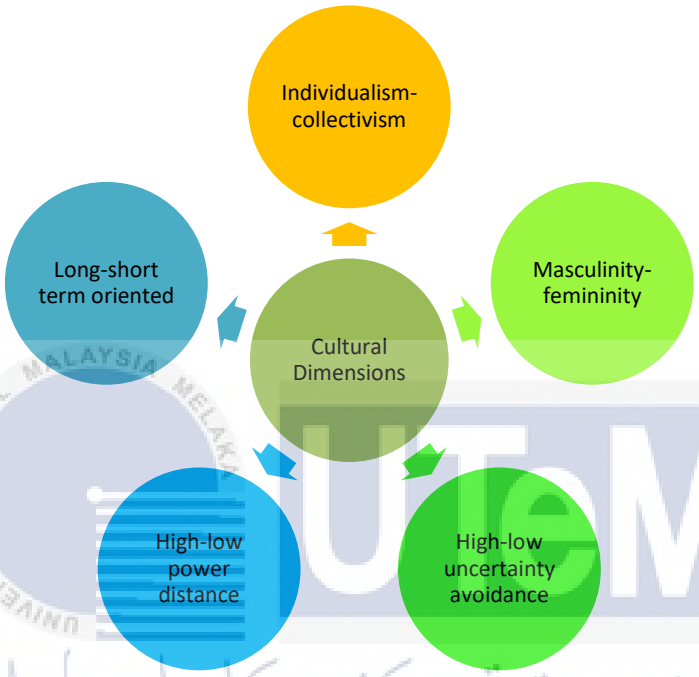

Figure 2.1: Hofstede's cultural dimension model (Hofstede 1993)

2.3.2.1 Individualism-collectivism

The term of individualism may be defined as a self-sufficient individual who is unconcerned about not belonging to a group (Soares, Farhangmehr, and Shoham 2007). Individualism is a personality trait that describes individuals who are more concerned with their individual interests than with the interests of a community. Individualists, according to Hofstede (1980), are those who believe for themselves. On the one hand, there is individualism vs. collectivism, which refers to the degree to which individuals are linked into communities (Cordell 2019). Hofstede used a scale of 1 to 100 to determine if a country's culture is more oriented towards collectivism or individuality. As a consequence, nations scoring above 50

are individualists, while those scoring below 50 are collectivists (Minh 2015). According to Hofstede's research findings, Vietnamese's score is 20 and Finland's score is 63. Those scores mean Vietnam and Finland are collectivist country and individualistic country respectively (Minh 2015). Thus, this study examined the consumer preference by using cultural dimension produced different results between individualism and collectivism will affect consumer behaviour on applying water consumption in ablution, particularly among Muslim in Malaysia.

2.3.2.2 Masculinity-femininity

Masculinity and femininity refer to the gender roles dispersion, which is another essential issue for each culture to which a variety of solutions are discovered (Cordell 2019) . Women's values differ less between societies than men's values, according to IBM research; men's values vary greatly from country to country, ranging from very assertive and competitive and maximally different from women's values on the one hand, to modest and caring and similar to women's values on the other (Cordell 2019). It was also stated that a high standard of masculinity contributes to an individual's goal, accomplishment, task, and achievement, success, competitiveness, and aggressiveness (Hofstede, 1993). Meanwhile, femininity is the polar opposite of masculinity, with a focus on physical and mental health, societal care, unity, unity, and sustaining warm personal relationships with others (Mohd Aiman bin Mohd Fauzi, Jaanavee Devi a/p Sundaresan, and Abidin 2020) . According to (Johari et al. 2013a), with the majority of males and females disagreeing that excessive intake may be classified as a waster when doing the ablution ritual and referring to the Quran, all of them agreed.

2.3.2.3 High-low uncertainty avoidance

The Uncertainty Avoidance Index measures a society's tolerance for complexities, and it ultimately pertains to man's quest for truth (Soares, Farhangmehr, and Shoham 2007). People who live in places where there is a lot of uncertainty are also more emotional and motivated by their inner nervous energy. It demonstrates how much a society has conditioned its citizens to feel uneasy or at ease in unstructured situations. Unstructured circumstances are unique, unfamiliar, startling, and out of the ordinary (Hofstede, 1997). Uncertainty-embracing societies, on the other hand, are more accepting of differing opinions because they strive for as few laws as possible, and they are relativists who allow several currents to flow side by side on a philosophical and religious level (Arof, Ismail, and Saleh 2018). Individuals in these cultures are more gregarious and thoughtful, and they are not required to exhibit emotions by their surroundings (Suratkon, Chan, and Tuan Ab Rahman 2014).

2.3.2.4 High-Low Distance

Hofstede's high-low distance refers to how many national cultures anticipate and accept that power is unfairly allocated in society (Basabe et al. 2002). In general, the dimension of power distance is connected to the organization of power in society, including differential benefits for persons of high to the low level (Kim and Zhang 2014). Furthermore, cultures with high power distance make it possible for everybody to have a fixed position in the social order. In contrast, the norm is to maintain and respect the equality inherent in social interaction in the low-power distance beliefs (Oyserman 2006). This overall shows that a high power differential in cultures with a high power distance is accepted.

2.3.2.5 Long-short term oriented

Long-term thinking focuses on the future and the willingness to forego present gratification in order to achieve long-term success (Hofstede, 1997). Long-term direction is also defined by resilience, persistence, and long-term progress. (Bissessar 2018) also purposed in his research that long-term goals are set and long-term orientation is directed toward delayed gratification. Meanwhile, a short-term oriented culture, on the other hand, is more concerned with free time, independence, short-term accomplishment, and individualistic or individualistic values (Bissessar 2018). Short-term personalities are generally more concerned with the immediate outcome, believing certainty, and current goal attainment. In other words, those who are religious placed a higher value on values, consistency, and truth. Thus, environmental concerns have been more significant in empirical research in recent years, particularly on water waste in water usage for ablution based on the behaviors among Muslim's population.

2.3.3 Conceptual Model Development

2.3.3.1 Hypotheses and preferences evaluation

The evaluation the customer preferences and cultural value influences is used to find the attribute for the water monitoring online. For example, Bloch (1995), and Salmi and Sharafutdinova (2008) described that the cultural values can be used to identify the customer preferences on a specific product. The goal of these studies was to determine customer preferences for traditional product qualities. There is a dearth of research into the effects of cultural value on customer preferences for products. As a result, this research proposes to broaden the scope of its examination into the effects of cultural values on customer preferences for water monitoring online product qualities. Thus, in order to determine preferences, the preferences attributes must be extended to product features or characteristics. The framework

to evaluate the cultural value influences on water monitoring system attribute in this study, is illustrated in Figure 2.2.

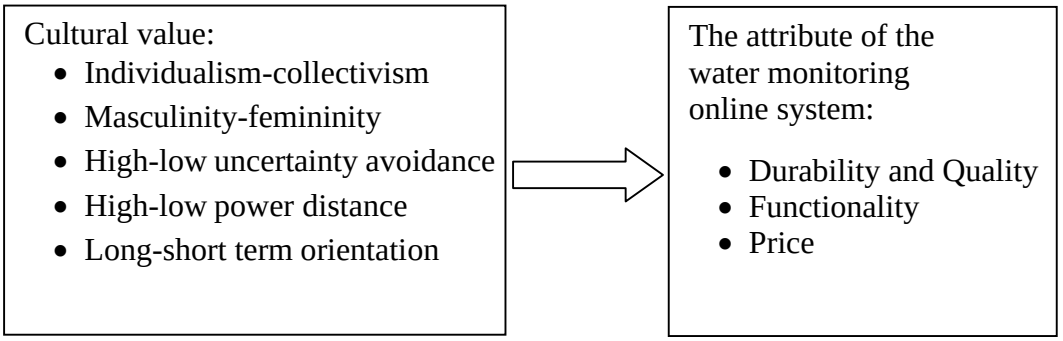

Figure 2.2: Framework to identify cultural value attribute on water monitoring online system.

2.4 Water Consumption according in Malaysia for ablution at mosque

2.4.1 Overview of Ablution

Ablution is derived from the Arabic word al-Wadha'ah, which signifies cleanliness and brightness, and it may be regarded as a physically and spiritually act (Hamid et al. 2016). Ablution is a Muslim ritual activity, especially in Islam which is washing a part of body and a set of tasks that must be completed in order for Muslims to pray and also based on the religious beliefs. Besides, it has been recorded in the Al–Quran which is the guidance for a Muslim to abide the instructions and teachings in Islam. According to (Suratkon, Chan, and Tuan Ab Rahman 2014), a Muslim must wash exposed body parts with clean water as part of the wudhu' ritual, which is known locally as wudhu'.

The ablution function involves cleaning with fresh water certain parts of the body in a certain steps and according to right order. Thus, there are a few steps required in performing completed ablution for Muslims. It starts with intention on performing wudhu’ ritual, followed by washing both of hands, mouth, nose, face, both of arms including the whole elbows, forehead, ears, and both of feet up to the ankles respectively. Based on the previous research by (Dawood n.d.), he mentioned on the messenger of Allah (sallAllahu ‘alayhi wa sallam)

said, which is when an individual rinses his mouth, all sins of his mouth are washed away; similarly, When he washes his face, all sins of his face are washed away, including sins beneath his pupils; when he washes his hands, all sins of his hands, including sins of his nails, are washed away; similarly, when he wipes his hands over his head, all of his sins, including those of his ears, are washed away.

2.4.2 Quantity of Water Consumption in Ablution

Water is a vital component of life, which means a part of requirements for humans, animals, flora, and all living things. Thereby, it is an essential for drinking, cleaning, farming, and other purpose of activities in daily life. According to (Johari et al. 2013b), he mentioned that in a public building like mosque, water is essential for purification activity such as ablution (wudhu), bathing, toilet use, landscaping and other purpose. Therefore, mosque is a place of worship that is open to everyone, particularly Muslims to perform compulsory activities in Islam such as prayer. In other words, ablution is an obligation whereby an individual of Muslim that must be attained beforehand to performing wudhu, or religious cleaning and purifying, in required to conduct Muslim prayer. Thus, ablution is compulsory to be done before performing praying at five times a day and required an amount of water consumption.

Due to this situation, the amount of water required is estimated less than 1L by per person. Besides, (Yusof et al. 2020) mentioned that the average Muslim uses 5L of water for ablution, but it is suggested that a Muslim needs up to 25L of filtered raw water for ablution and during Friday prayer will caused the amount of water consumption will be doubled. As consequence, a great amount of water is used in the ablution process, particularly in mosques where tap water is permitted to flow freely and drain away.

2.4.3 Ablution Consumer's Behavior in Water Consumption

Water conservation measures can be categorized as non-technical measures which is including information, education, and awareness that may change consumer behaviors towards water consumption. There are several factors that affect consumers in water consumption, particularly in ablution activities which determined on consumer's behaviors towards water usage in ablution. The factors are namely as value and attitude which are crucial life objective that are accepted and learnt through others that related in their personal life and involved in daily activities such as families, work and community surroundings, friends' experiences, and the public (Aiman et al. 2019). The ideals which have been established in an individual perception will serve as a powerful motivator and guide in defining value and attitude. The ideals that a person adheres to might also be linked to the surroundings. Individual actions are linked to conduct that is based on an individual's or group's akhlaq and morality. To put it another way, it refers to the perceived discipline that shows a society's value system. Both perspectives emphasize the need of disciplining an individual in order to construct a noble characteristic or personality of some peoples (Raduan, Ibrahim, and Yaacob 2018).

Furthermore, attitudes toward sustainable water consumption relate to an individual's or a group's conscience in recognizing and choosing the optimal strategy to preserve and manage existing water resources (Paul et al. 2018). To put it another way, it refers to the inherent discipline that shows a society's moral code. The waste of water during ablution was caused by a lack of understanding and skills in managing people's attitudes. In the context of culture, the ways in which religious and cultural beliefs can impact on the perceived value of water, as well as notions of cleanliness with regard to water (Ooi et al. 2014). Individuals with highly favorable views toward water conservation and the environment rescued more water than those with somewhat favorable attitudes. As consequence, individuals who constantly

search over and pay close attention to water conservation information are more reluctant to commit water conservation intentions, even though the benefits are minor.

2.5 Related work

2.5.1 Water Quality Monitoring System Based On Wireless Sensor Network & Solar

Yue & Ying (2012), proposed a water quality system which made by a base station and several sensor nodes. The base station has a PC and a wireless receiver that use to receive the data from the transmitter of sensor. Figure 2.3 below shows the overall system on this architecture. The sensors is place at sites area and it is transmitted the data through a wireless sensor network (WSN). There are four modules to operate this system to work: solar power, sensor, interface circuit and SunSPOT.

Figure 2.3: Overall System Architure

For solar power module, it use solar cell to provide a power to the other modules. It contains solar panel, accumulator and regulator. Due to sunlight changes day and night, the accumulator is use to stabilize the output voltage of solar panel. When the sunlight is strong and the output of solar is higher than 12V, the regulator is turns on and the accumulator is charging. But when sunlight is weak and the output below than 12V, the regulator is off and the system is using the power from the accumulator 12V output. Next, in sensor module, there are using three sensors which are turbidity, pH and Redox sensor. The turbidity sensor is use to check the clarity of the water. While, pH sensor is used to measure the acidic of water and Redox sensor is use to detect the density of oxygen in water. After that,

the data from sensor is sent by using wireless network sensor. The software communication is design based on SunSPOT which divided into two part; data receiver and sender.

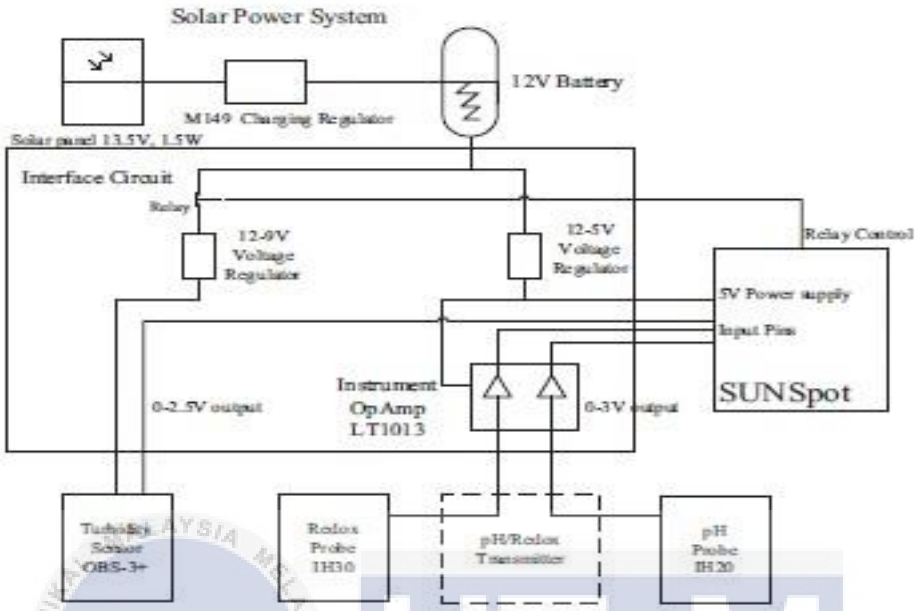

Figure 2.4: Detailed Block Diagram of System

2.5.2 Water System Monitoring and Control Using Zigbee in Real Time

Maqbool & Chandra, (2013),introduced a system that can monitor and control the water system in real time by using Zigbee 802.15.4. This project is designed to check the water level and the quality of water with help of multi sensors at water tanks bore wells, rivers and flood areas. The multi sensors include level sensors, pH sensor, turbidity sensor and oxygen dissolved sensor. The aim of this project to designed a system that is simple, low cost, energy efficient and sustainable. To control and monitor the water level of tanks and bore wells, the level sensor is put on the place. When water touched the level sensor, it will transmit a signal to the PC by using Xbee to perform required action of water pump (ON/OFF). Next, to check water quality the sensor; pH sensor, turbidity sensor and dissolved oxygen sensor are place on water surface. The data of sensors is sent to the Coordinator

through XBee nodes. At the same time this information also sent to the owner by using the GSM technology.

Figure 2.5: Architecture of System Monitoring and Control Using Zigbee in Real Time

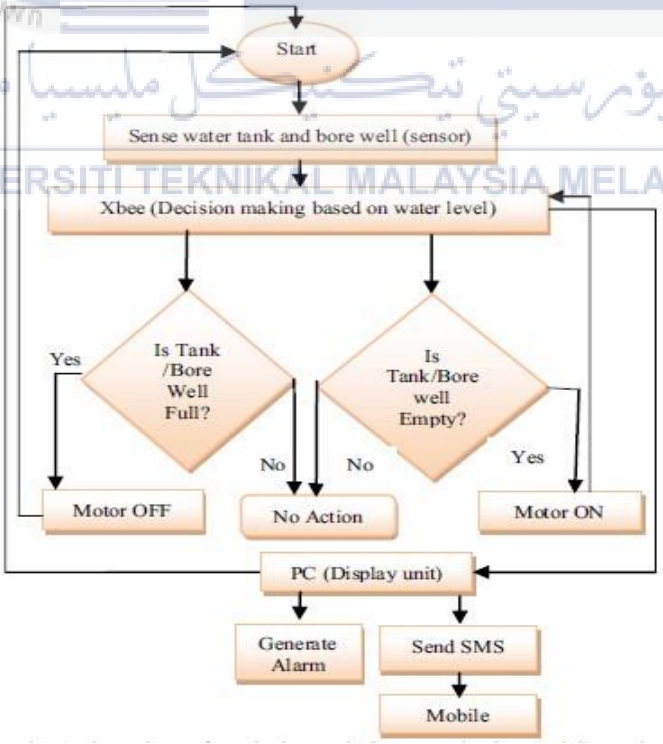

Figure 2.6: Flow chart of Water System Monitoring and Control Using Zigbee in Real Time

2.5.3 Real-Time Monitoring and Contamination Detection In Drinking Water

S Theofanis P. Lambrou (2014), developed water distributions system of a low cost to the water quality monitoring problem for drinking water. The system is based on the development of low cost sensor nodes for real time and in pipe monitoring of water quality. The parameter that needs to be monitor includes turbidity, temperature, pH, and oxidation reduction. Convectional (pH and ORP) glass electrode and solid states sensor (TU, EC and T) are used to get the measurements of water quality.

Table 2.1: Parameter of Water Quality to be monitor

	Parameter	Units	Quality Range	Meas. Cost
1	Turbidity	NTU	0 – 5	Medium
2	Free Residual Chlorine	mg/L	0.2 – 2	High
3	ORP	mV	650 – 800	Low
4	Nitrates	mg/L	<10	High
5	Temperature	°C	–	Low
6	pH	pH	6.5 – 8.5	Low
7	Electrical Conductivity	µS/cm	500 – 1000	Low
8	Dissolved Oxygen	mg/L	–	Medium

There are three subsystems in this system; central measurement that collect data from sensor, the implementation of algorithm to other nodes and receives the information to user. Programmable Intelligent Computer (PIC) that have 32 microcontroller is used as the central measurement nodes that collect all data information from the sensors. These data information is sent to user to notify the condition of water quality that been monitored. ZigBee RF transceiver provides a gateway to internet; send email/SMS and alerts notification to the user.

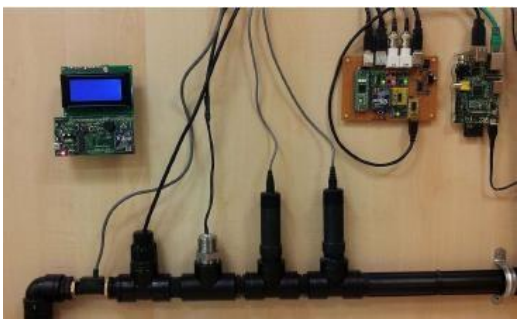

Figure 2.7: Architecture Design of Water Monitoring and Contamination System

The overall power consumption of the central measurement sensor node with LEDs on board and the RF Xbee transceiver module is about 50mA at 5V operating voltage. This power consumption can be minimizes by using a hibernations schemes but it can use in further improvement. Furthermore, the software platform enables real times measurement charts of monitored parameter, assessment of water quality and sensor calibration through a Graphical User Interface (GUI). It also logs sensor data in a local database and posts data to web using Pachube open source web platform. In open source, the user can set various thresholds for sending notifications via messages or email.

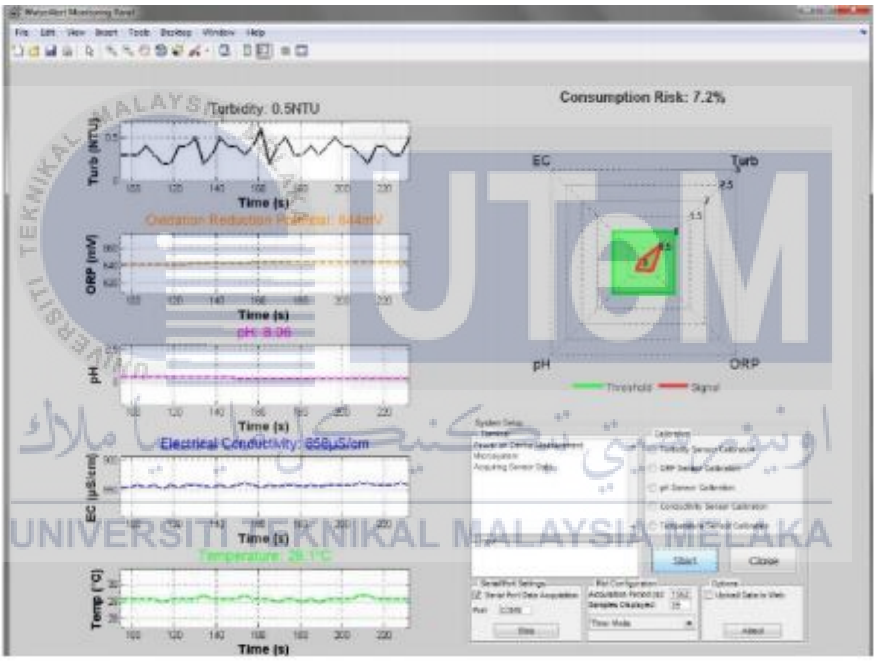

Figure 2.8: Graphical User Interface (GUI) platform

When abnormalities are discovered, the contamination event detection was designed and tested to allow these sensor nodes to make decisions and activate alarms. By fusing the multi-sensor data, these anomalies of water quality parameters must be monitored to see if they have changed within the expected quality ranges. To assess the danger of water pollution, two event detection algorithms were designed to fuse on-line multi-sensor measurements. Vector Distance Technique (VDA) is the first event detection algorithm, and Polygon Area Algorithm (PAA) is the second (PAA).

The sensor node (central measurement node) collects samples every 5 seconds from potable water passing through a flow cell in the experimental setup. The performance of the event detection algorithms was examined in real time after intentional contamination of two significant contaminants (escherichia coli bacteria and arsenic) of varying concentrations was injected at discrete time intervals.

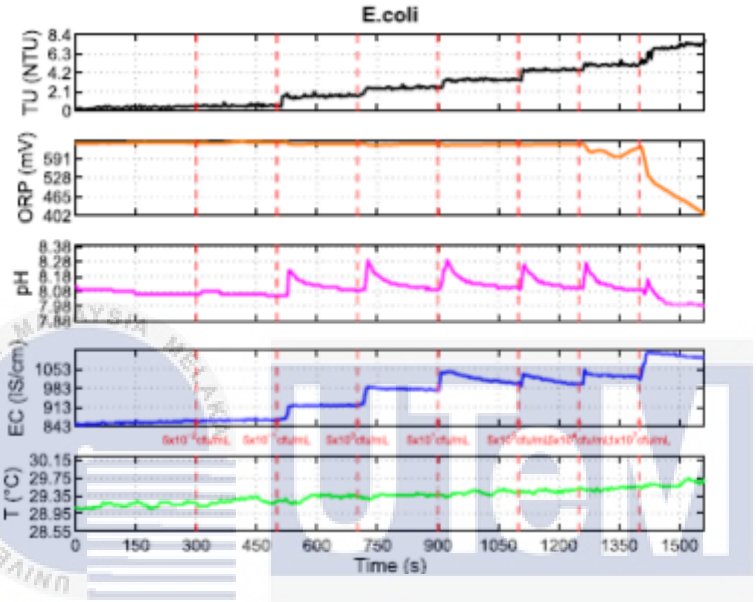

Figure 2.9: Experiments with E.coli bacteria contaminated water.

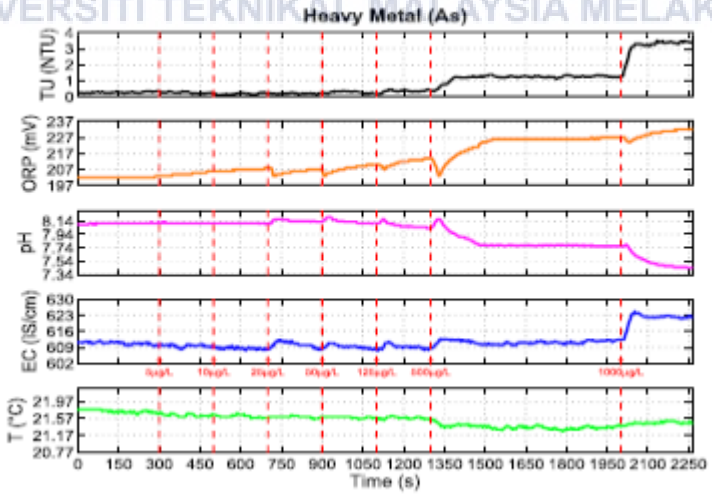

Figure 2.10: Experiments with Heavy metals (Asenic) contaminated water.

2.5.4 System Water Quality Monitoring System in Real Time

Mithila Barabde (2015) did a thorough examination of data monitoring nodes, a base station, and a distant station make up a water quality monitoring system. All of these stations are connected by wireless communication lines. The nodes' data is transferred to the base station, which is made up of an ARM controller designed for a small space application. The remote monitoring station receives the pH, turbidity, and conductivity data collected by the base station. The data collected at the remote site is displayed on a server PC and compared to standard values using MATLAB. If the obtained value exceeds the threshold value, an automated warning SMS alert will be sent to the agent.

This project's main purpose is to develop a system that employs wireless sensor networks to continually monitor water quality in remote places with low power consumption, low costs, and high detection accuracy. The parameters that need to analyze are pH, conductivity and turbidity level to improve the water quality.

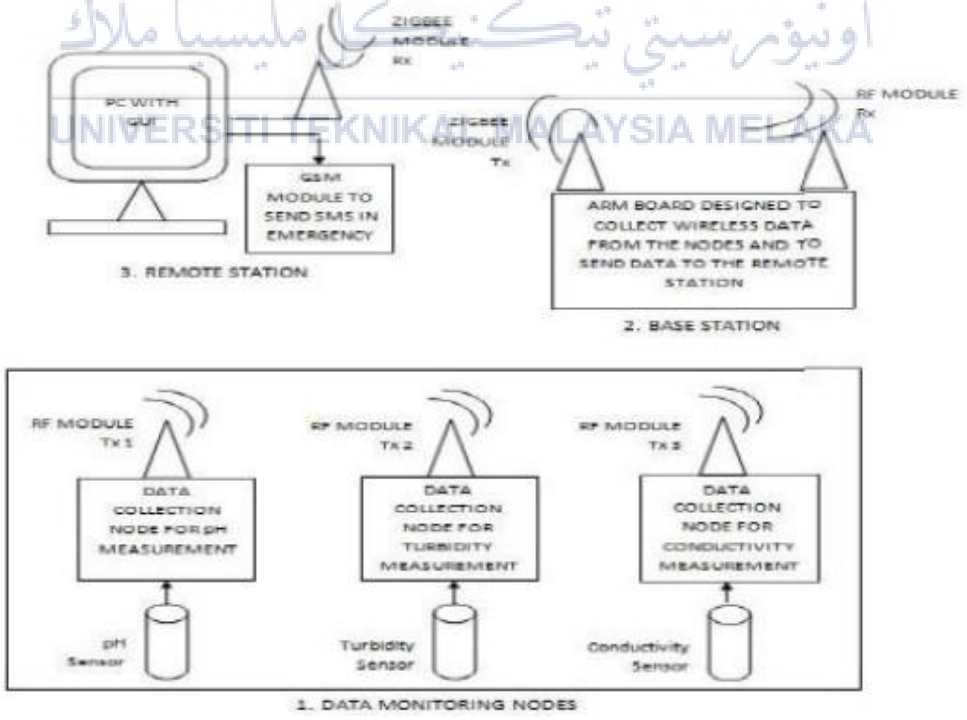

Figure 2.11: Block Diagram of Water Quality System.

There are two parts in this system which is hardware and software:

i) Hardware Part

(a) Monitoring Data Nodes

This system consists of sensors (pH, turbidity, and conductivity), a signal conditioning circuit, a controller, and an RF module. The data from the sensor will be sent to a signal conditioning circuit, which will change the analogue signal to meet the requirements of the next stage for processing. The controller (PIC16F877A) will then be supplied the altered data. For additional processing, the built-in ADC converts the analogue signal to a digital signal. The RF module will be used to transfer the altered detected data to the data base station.

(b) Base Data Station

The data from all of the nodes is gathered at the data base station, which is comprised of an ARM Processor (LPC2148). Time multiplexing is used to collect data from each node one after the other. This information is shown on an LCD screen. This information is also sent to a remote monitoring station through a Zigbee module.

(c) Monitoring Remote Station

A Zigbee module is included in the remote monitoring station, which will receive data from the data base station. This information will be sent via serial communication to a server PC with a Graphic User Interface (GUI). With the help of MATLAB, the gathered data will be visually depicted and preserved for future reference. The acquired data is also compared to the water parameter standard values. If the collected water parameters do not match the current value, an SMS will be sent to an authorised person so that preventative steps can be taken.

ii) Software

The software design for a water quality monitoring system is divided into three parts: PIC programming, ARM programming, and MATLAB GUI design. MPLAB IDE version 8.92 is used for PIC programming, while Keil uVision4 IDE is used for ARM programming. The programming language utilised is Embedded C. The MATLAB software was used to effectively construct the GUI platform, which can interact with the hardware at the remote monitoring station.

2.6 Summary of Previous Work

Table 2.2: Summarizations of previous researcher's journals water quality

No.	Journal	Objective	Methodology	Outcomes
1.	Yue & Ying,(2012)	Water quality should be monitored in real-time at several field sites.	Powered by a solar panel and using wireless sensor network (WSN) technology.	A system with a single sensor node and base station that monitors water quality in real time via a PC GUI window.
2.	Maqbool & Chandra,(2013)	To remotely monitor the water level of water systems.	Water level sensors, Zigbee 802.15.4, 74HC14 inverter, and GSM technologies are all used to help.	A system that is dependable, versatile, cost-effective, and simple to configure that can

No.	Journal	Objective	Methodology	Outcomes
				tackle the problem of water loss.
3.	S Theofanis P. Lambrou (2014)	Development of sensor nodes for on-the-fly water quality monitoring in real time and in-pipe.	Sensor nodes are made up of a variety of in-pipe electrochemical, optical, and low-cost, lightweight, and long-lasting sensors.	A low-cost sensor node for monitoring the quality of drinking water in real time.
4.	Mithila Barabde,(2015)	To develop a system for continuous monitoring of water quality at remote places	Measure water parameters and data send to base station by wireless channel to analyze using MATLAB and the SMS is send to an authorized person.	An execution of Zigbee based WSN for water quality monitoring system with low power and low cost.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, research methodology used both qualitative and quantitative methods in this study. The study was focused to identify the influences of cultural values towards the customer preferences on the water monitoring system online. The results obtained are based on qualitative data to supports the quantitative data. It is used for experimental survey to test the hypothesis through all materials such as figures, survey forms, data, analysis, and output. A brief review of the research topic and research questions will also be explained. The methodology of this project will be focus on the literature review where it required organizing to achieve the project objective accordingly. The flow of this project will be depicted graphically using flow charts, along with some basic explanations. To avoid wasting time due to insufficient or inefficient time management, all phases in the project were planned and structured, beginning with the literature research, data gathering, project simulation, project analysis, and producing the project report.

3.2 Research Design

This qualitative research taken part in research of case study. A case study method can be described as an exploration of a real life, contemporary bounded system (a case) or numerous bounded systems (cases) over time, through comprehensive data collection involving multiple sources of information (Creswell,2012). In this case study, a Google Form questionaire is used. The questionaire had specific questions regarding the emerging IoT technology in ablution based on Malaysian cultural preferences.

The research instrument was used to ask probing questions, which helped uncover what challenges are faced and what perceived opportunites exist in the implementation of IoT infrastructure in ablution activity that replace the manual system and techniques. This research utilized a qualitative to uncover unknown issues and perceptions towards emerging technology in ablution activity in Malaysia. It is essential to understand if the participants will accept or deny a platform that will oursource the replacement of manual water monitoring with one that is automated using smart IoT technology. By utilizing technologies such as the IoT water monitoring system can replaced the old manual water monitoring system which can increase the reliable of the water monitoring system for better.

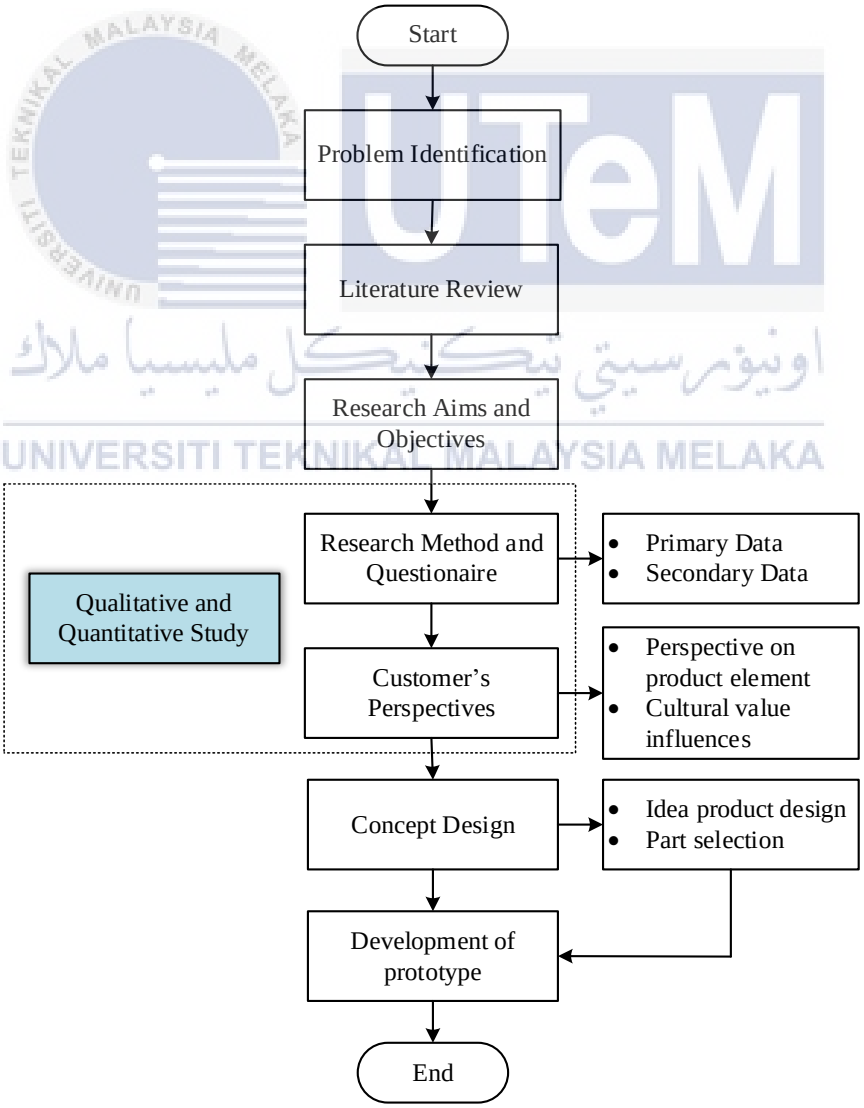

Figure 3.1: The research methodology used in this study

3.3 Data Collection

After the researcher has clearly identified the study difficulties, the researcher may determine which appropriate approach to employ for data collecting (Kothari, 2004). Before the researcher performs the data collection, there is a need to indicate the types of data will be needed and the suitable methods that should be used for the data collection. The primary data required for this study was obtained from the customers. Firstly, the data from the customers was used to identify the significant relationship between the cultural value influences and the identify the preferences on product characteristics with consideration on the cultural value influences. The data obtained from the customers was used to identify their perspectives on the cultural value consideration on the water monitoring online. The secondary data used in this study was obtained from the past research study. This data is useful to support the product development that were obtained from the customers' perspectives.

3.3.1 Data collection on customers

3.3.1.1 Questionnaire development

In this study, a questionnaire was employed to obtain data on customer preferences. In order to get a high level of data collection, the researcher must first decide how to design the questionnaire. A pre-testing of the questionnaire is also required to determine the comprehensibility of the questions that the respondents will be asked to answer. The design of the questionnaire, the scale used in the questionnaire, translation of the questionnaire and the pre-testing of the questionnaire.

3.3.1.2 Design of the questionnaire

1. Section A

This part includes five questions about gender, age, race, marital status, and education qualification. The respondents were asked to choose each question.

2. Section B

In this section, there are three part which part A for durability and quality aspect. In part A, there are three type of question which are for the long-term used, maintenance and water resistant. Meanwhile, part B is for about the product functionality. There are three type of question in part B which are the easiness of using product, additional function embedded and usefulness of the product functions. Lastly, part C which will be ask about the product price. There are three type of question in part C which are the affordable in price, low cost for maintenance and the easiness of obtained part in the market.

3.3.1.3 Pre-test and pilot study

A pre-test is a small-scale examination of the understandability and appropriateness of questions that will be included in a regular survey (Sekaran & Bougie, 2010). The pre-test was used in this study to guarantee that the respondents had no difficulty answering the questions. The questionnaire was provided directly to the respondents in order to determine whether they had any difficulties filling it out. Following the completion of the pre-test, the questionnaire was circulated for a pilot test. The pre-test and pilot study were designed to ensure that respondents had no problems filling out the questionnaire. After they have been finished and the respondents have no difficulty filling out the questionnaires, the actual survey can begin. However, because the analysis of the pilot study is not the primary goal, the sample size is usually not specified.

3.4 Data Analysis

In this study, the data analysis to identify the cultural value influences on the online water monitoring system was classified into three steps. In the first step, analysis on the data adequacy and reliability were performed. This is important to ensure that the collected data and its reliability, exceed the critical threshold. Once this has been completed, the next step is to extract the items used by performing the EFA. The Statistical Package for Social Science (IBM SPSS) (version 22, IBM, NY, USA) was used to evaluate all the calculations involved in the first step. In the second step, after all the critical threshold for the data reliability, sampling adequacy and factor analysis were evaluated, the next step was to confirm the validity items used by performing the CFA. Once the validity has been confirmed, the final step was to evaluate the developed hypotheses. The partial least square-structural equation modeling (PLS-SEM) approach was applied to assess the developed hypotheses. SmartPLS (version 3, SmartPLS GmbH, Bönningstedt, Germany) was used as a tool to evaluate all the validation of the items in the CFA and hypotheses development. A more detail explanation of these three steps is discussed in the following section.Data analysis in qualitative research includes the process of data evaluation, data categorization, data organization and data assessment. Research should have a strategy that frames the particular decisions as to what will be assessed, the assessment's reasoning and how the data will interpret (Yin,2018). The researcher needs to excogitate all evidence, including data that is conflicting. This process ensures that the analysis technique used addresses the study's primary purpose (McCallister, 2019; Tellis, 1997). As stated earlier, data was collected for this research utilizing a Google Form questionnaire. In Chapter 4 of this dissertation, the researcher will present the information gathered during the data gathering process as well as the results of the data analysis.

3.5 Concept Design

3.5.1 Block Diagram

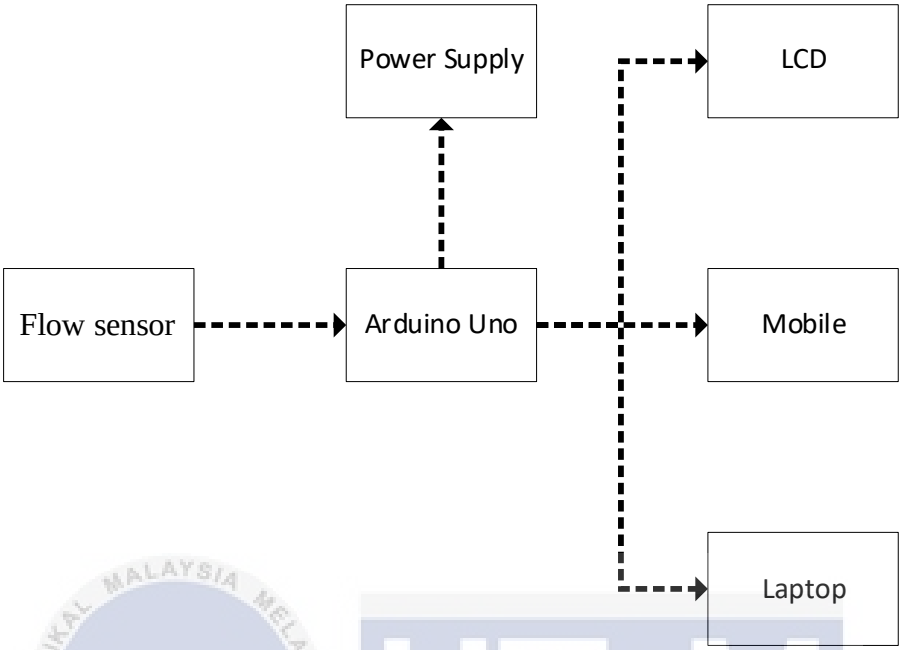

Figure 3.2: The block diagram of water flow system monitoring online.

3.5.2 Hardware Development

3.5.2.1 Arduino Board

A textual content editor for writing code, a message location, a textual content console, a toolbar with buttons for common functionality, and a series of menus are all featured in the Arduino development environment (IDE). It communicates with and uploads apps to the Arduino and Genuino hardware. In other words, sketches relate to program created using the Arduino software (IDE). These sketches are created using a text editor and saved as a document extension. The editor includes tools for cutting and pasting, as well as searching for and replacing text. The message area provides feedback during saving and exporting, as well as displaying errors. The Arduino software program (IDE) is used to display textual content, as well as entire mistakes messages and other facts, on the console. The configured board and serial port are displayed in the window's lower right-hand corner. Confirmation and adding

programmes, create, open, and save sketches, and open the serial monitor are all done through the toolbar buttons. It included the Arduino software development environment (IDE) with some instructions inside the five menus, including file, Edit, sketch, tools, and help. The menus are context sensitive, which means that only the things that are relevant to the work at hand are available. Figure below show the Arduino software IDE.

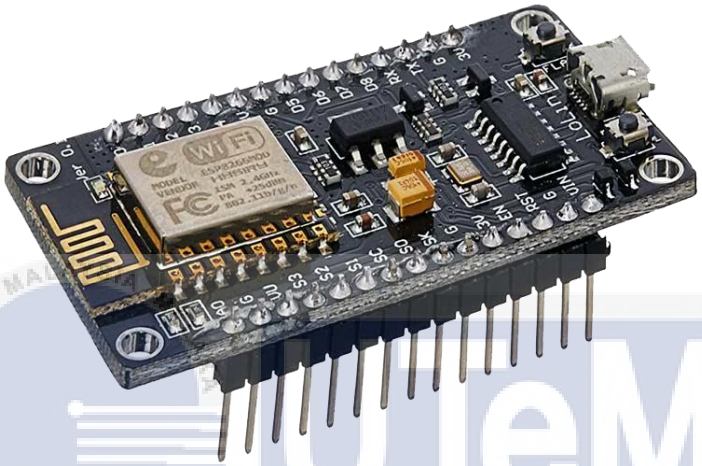

Figure 3.3: Arduino Board

3.5.2.2 Flow Rate Sensor

The sensor need to has both an inlet and an outlet, the YF-S201 Hall-Effect Water Flow Sensor is the perfect to be use in any kind arduino project. This sensor can be mounted to the waterline. The amount of liquid that has flowed through the sensor is measured by a pinwheel inside the sensor. An electrical pulse is generated by an implanted magnetic hall effect sensor with each revolution. The pinwheel sensor in this sensor sits in line with your water line and measures how much liquid has gone through it. The hall effect sensor is isolated from the water pipe, ensuring that it remains safe and dry. Red wire is for 5-24V DC power, black wire is for grounding, and yellow wires are included with the sensor (Hall effect pulse output). Each pulse contains about 2.25 millilitres.

Figure 3.4: Flow Rate Sensor

3.5.2.3 OLED Display

The emissive electroluminescent layer of an organic light-emitting diode (OLED or organic LED), also known as organic electroluminescent (organic EL) diode, is a film of organic compound that emits light in response to an electric current. This organic layer is sandwiched between two electrodes, at least one of which is usually transparent. OLEDs are used to make digital displays in a variety of devices, including televisions, computer monitors, cellphones, and handheld game consoles. The development of white OLED devices for use in solid-state lighting applications is a key field of research.

Figure 3.5: OLED Display.

3.5.2.4 Connecting Wire

Connecting wire is an electrical wire, or bundle of electrical wires in a cable, with a connector or pin at each end that is generally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are joined by fitting their "end connectors" into slots on a breadboard, the header connection on a circuit board, or a piece of test equipment.

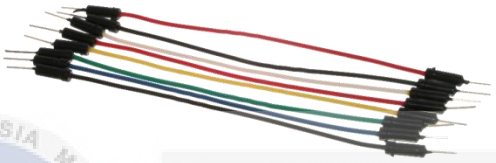

Figure 3.6: Connecting wire

3.5.2.5 Wire Breadboard

A breadboard, often called a protoboard, is a building platform for electronics experiments. The term was originally used to describe a polished piece of wood used for slicing bread. In the 1970s, the solderless breadboard (also known as a plugboard or a terminal array board) became popular, and the name "breadboard" has now come to apply to these boards. Because it does not require soldering, the solderless breadboard can be reused. This makes it simple to use for making temporary prototypes and circuit design experiments. Solderless breadboards are therefore popular among students and in technology education. This was not a feature of older breadboard models. Stripboards and other prototyping printed circuit boards, which are used to create semi-permanent soldered prototypes or one-offs and

cannot be reused easily. Breadboards can be used to prototype a wide range of electronic systems, from simple analogue and digital circuitry to entire central processing units (CPUs).

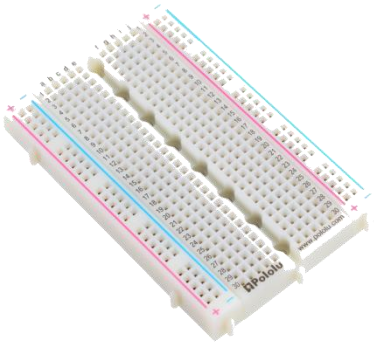

Figure 3.7: Breadboard

3.5.3 Software

3.5.3.1 Arduino IDE

The Arduino IDE is a cross-platform Java application that may be used to modify code, compile it, and send firmware to the board serially. In addition, the Arduino IDE simplifies programming by employing a simplified version of C++. The Arduino integrated development environment (IDE) is a Java-based cross-platform tool that may be used on Windows, Mac OS X, and Linux. It includes a code editor that allows for text cutting and copying, text substitution, automated indenting, brace matching, and syntax highlighting, as well as one-click compilation and uploading to an Arduino board. A message box, a text terminal, a toolbar with common function buttons, and a hierarchy of operation menus are also included. The Wiring project is a software library for the Arduino IDE that includes a variety of standard input and output operations. User-written code just needs two basic functions to start the sketch and run the main programming loop, which are built and linked into an executable cyclic executive programming with the help of a programming stub main. The Arduino IDE converts program executable code into a text file in hexadecimal format, which is then loaded into the Arduino board's firmware via a loader software.

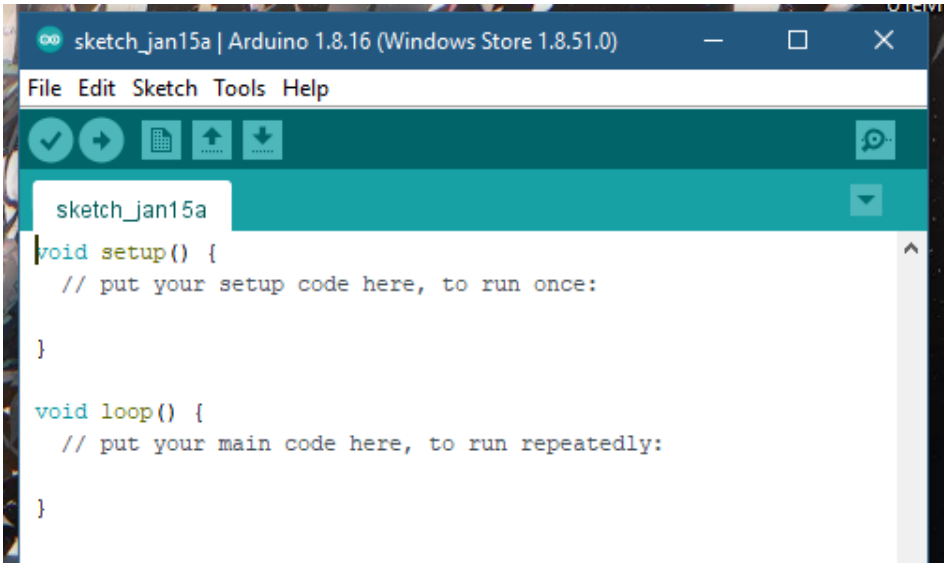

Figure 3.8: Arduino Software IDE

3.5.3.2 ThingSpeak

ThingSpeak is a cloud-based IoT analytics tool that lets you aggregate, visualise, and analyse live data streams. ThingSpeak delivers real-time representations of data sent to the platform by your devices. With the ability to run MATLAB code in ThingSpeak, you can analyse and handle data as it comes in real time. ThingSpeak is frequently used for IoT system prototype and proof of concept that require analytics.

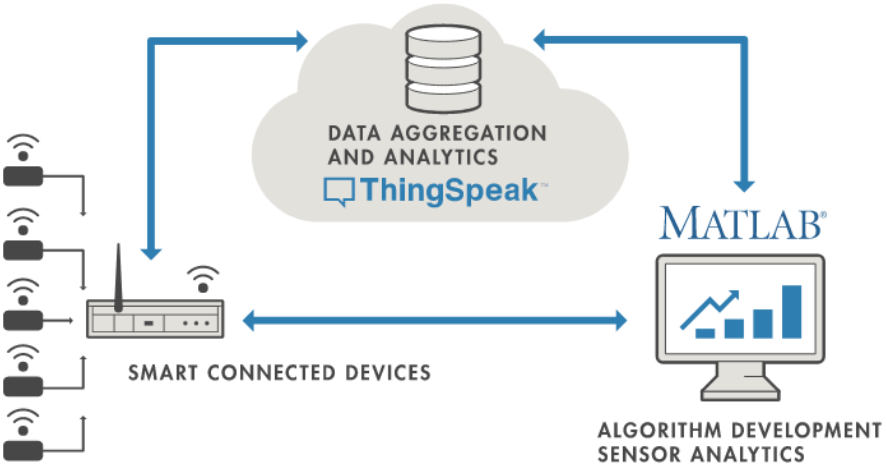

Figure 3.9: Diagram of ThingSpeak

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

The analysis process for evaluating on how cultural value influences the online water monitoring system is described in this chapter. The customer perspective, dependability, and validity were investigated using data collected from customer perspectives. Five cultural factors that characterise how cultural values effect the construction of water monitoring systems are individualism-collectivism, masculinity-femininity, long-short term orientation, power distance, and uncertainty avoidance. The concept of elements seen by their eyes may influence the customer's desire for the outcome. The preferences on online water monitoring system features can be determined using the output of the outer weight calculation to determine cultural value influences on online water monitoring system characteristics. In this section, data analysis being carried out from IBM SPSS Statistics 26.0 and SmartPLS 3.0.

4.2 Customer Perspective

4.2.1 Respondent Profile

This section determined the demographic profile of respondents that have been participated in particular study. Thus, the total number of respondents collected from the survey questionnaire through Google Form is (N=100). The data is from IBM SPSS Statistics 26.0.

Table 4.1: Total numbers of respondrnts's profile.

Statistics

		GENDER	AGE	RACE	RELIGION	EDUCATIONAL
N	Valid	100	100	100	100	100
	Missing	0	0	0	0	0

Table 4.2: Frequency of Respondent's Gender.

GENDER

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	61	61.0	61.0	61.0
	Female	39	39.0	39.0	100.0
	Total	100	100.0	100.0	

According to Table 4.2, the total number of respondents is (N=100). Male respondents exceed female responders by a factor of two. As a result, male respondents represent approximately 61 (61.0%) of the total, while the number of male respondents are 39 (39.0%).

Table 4.3: Frequency of Respondent's Age

AGE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	16-24	54	54.0	54.0	54.0
	25-34	44	44.0	44.0	98.0
	35-44	2	2.0	2.0	100.0
	Total	100	100.0	100.0	

The percentages of respondents' age are provided in Table 4.3 above. Besides, 54 respondents under the age 16 to 24 (54.0%). However, 2 (2.0 %) of the 100 respondents are currently between the ages of 35 to 44. For those between the ages of 25 to 34, the median proportion of replies is 44 (44.0%).

Table 4.4: Frequency of Respondent's Race.

RACE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Malay	96	96.0	96.0	96.0
	Chinese	3	3.0	3.0	99.0
	Indian	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

According to Table 4.4, the bulk of the respondents are Malay, with 96 (96.0%) of the 100 respondents. The other races include Chinese, with 3 (3.0%) being the second highest proportion for respondent race. Meanwhile, in the third stage, with 1 (1.0%) is an Indian's participant.

Table 4.5: Frequency of Respondent's Religion.

RELIGION

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Muslim	95	95.0	95.0	95.0
	Non - Muslim	5	5.0	5.0	100.0
	Total	100	100.0	100.0	

Based on Table 4.5, the results from the participants showed that the Muslim population who answered the question was higher with the number of 95 (95.0%). Meanwhile, the number of believers other than Islam is only 5 people (5.0%).

Table 4.6: Frequency of Respondent's Educational.

EDUCATIONAL

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	SPM	1	1.0	1.0	1.0
	STPM/Matriculation/A-Level	2	2.0	2.0	3.0
	DIPLOMA	18	18.0	18.0	21.0
	DEGREE	76	76.0	76.0	97.0
	MASTER/PhD	3	3.0	3.0	100.0
	Total	100	100.0	100.0	

According to Table 4.6, it shows that the highest percentage is from respondents that involved in different level of educations. There are 76 (76.0%) respondents that are undertaking or graduated from Degree level. Next, the highest percentage for educational level

is between Diplomas which 18 (18.0%). Next, followed by 3 (3.0%) respondents from educational background of Master or PhD. The rest are respondents coming from SPM and STPM level.

4.2.2 Analysis of Reliability Test

Most of the most crucial aspects of test quality is reliability. This has to lead by an examinee's test performance being consistent, or dependable. Thereby, (Bruin, 2011) mentioned that reliability is a key component in assessment and that it is portrayed as a component that contributes to validity rather than as a component that is in opposition to validity. The researcher used the Cronbach's alpha to test the variables. The Cronbach's alpha coefficient range of reliability that demonstrates how the objects are positively correlated. The reliability is considered unreliable, with less than 0.50, whereas 0.60 is considered poor. It is assumed to be approved and successful if the reliability is in the 0.70 and 0.80 range. Superb efficiency is beyond that, which is above 0.90.

Table 4.7: Cronbach's Alpha Coefficient Range Cronbach's

Cronbach's Alpha Coefficient Range	Strength of Association
>0.90	Excellent
0.80 – 0.89	Good
0.70 – 0.79	Acceptable
0.60 – 0.69	Questionable
0.50 – 0.59	Poor
<0.50	Unreliable

Table 4.8 : Reliability Results

Reliability Statistics

Cronbach's Alpha	N of Items
.779	34

The researcher all samples (N=100) of respondents to apply in reliability testing. Based on the Table 4.7, it shows that the reliability test that are 0.90 and above are represent excellent reliability results. Meanwhile, if the data is between 0.80 until 0.89 the data is good. According to the Table 4.8, which shown the data collected, the researcher found that reliability outcome for both cultural values and monitoring system variables are 0.779 which is indicate acceptable association. Thus, all the independent, and dependent variables are reliable based on Cronbach's alpha coefficient range to conduct further analysis in SPSS Statistic 26.0.

4.2.3 Confirmatory Factor Analysis

The Partial Least Squares (PLS) approach was used to perform the Confirmatory Factor Analysis (CFA). SmartPLS was applied as a statistical tool to analyses the data. The measurement model consists of both reflective and formative measures. HCM was applied to identify the relationships for the constructs of durability and quality, product functionality, and price to the customer preferences on water monitoring system.

4.2.4 Convergent Validity

To assure that a reflective measurement model is suitable, it should be tested for convergent validity. The examination of factor loading, CR, and AVE is required for convergent validity. The factor loadings should be at least 0.4 to 0.7 or higher, the AVE should be > 0.5, and the CR should be > 0.7, according to the recommendations. Despite the fact that the CR is in the range of 0.6 to 0.7, it is still suitable for exploratory studie (Hair et al. 2019). However, deleting the lowest elements in the allocated construct would be preferred if decreasing specific factor loadings can raise the AVE and CR. The computation process of the convergent validity for cultural in Malaysia data are presented in Figure 4.1. Meanwhile, Table 4.9 and 4.10 shows the factor loading, AVE, and CR estimations for cultural in Malaysia and online water monitoring system.

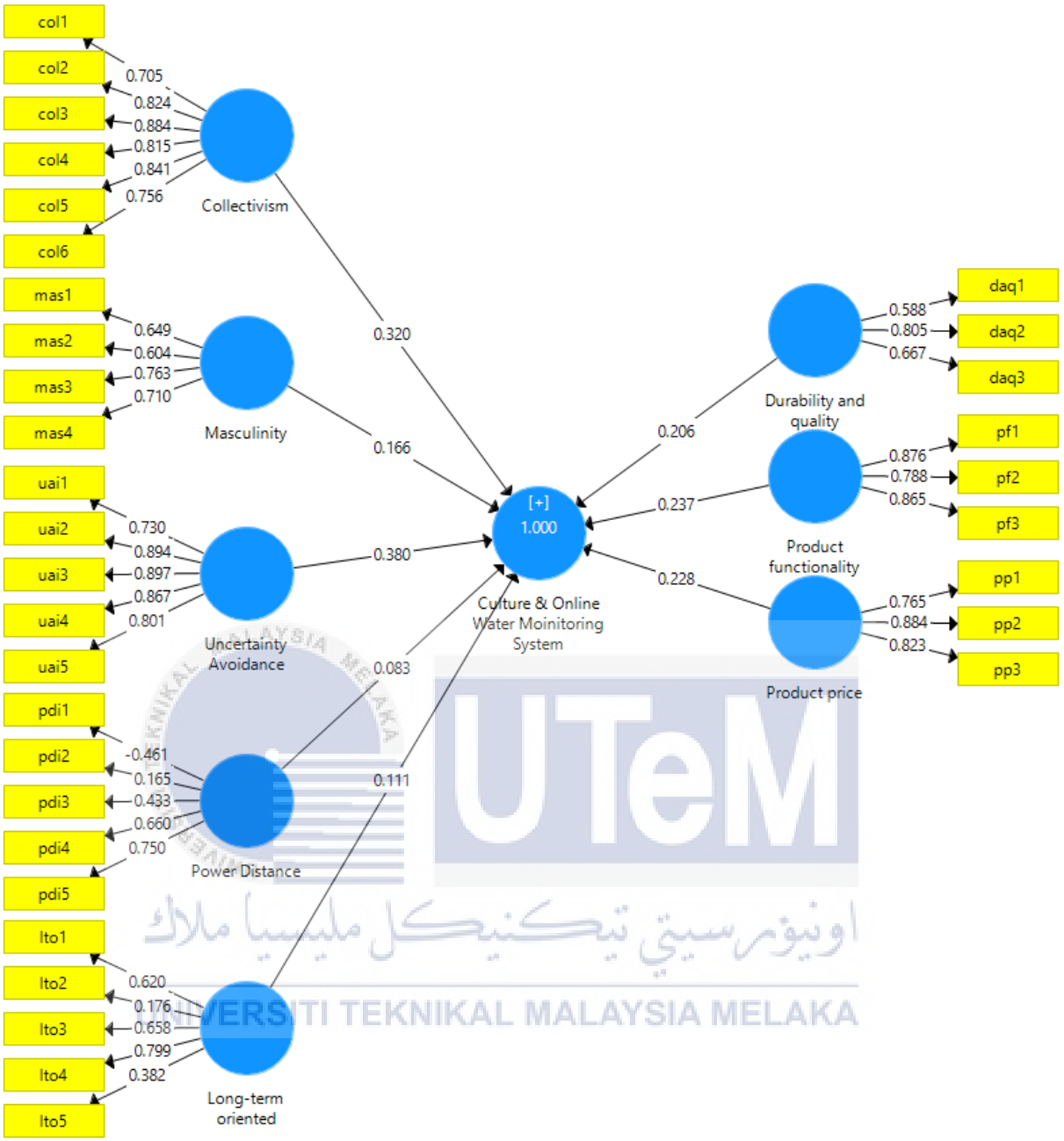

Figure 4.1: Outer loading computation of Culture and Online Water Monitoring System

Table 4.9: The factor loading, AVE and CR values of cultural in Malaysia

Cultural Value	Questionaire	Items	Factor loading	CR	AVE
Collectivism	Individuals should sacrifice self-interest for the group that they belong to.	Coll1	0.705	0.917	0.65
	Individuals should stick with the group even through with harsh difficulties.	Coll2	0.763		
	The group's welfare is more important than individual rewards.	Coll3	0.851		
	The group's success is more important than individual success.	Coll4	0.861		
	Individuals should pursue their goals after considering the welfare of the group	Coll5	0.831		
	Group loyalty should be encouraged even if individual's goals suffer.	Coll6	0.684		
Masculinity	It is more important for men to have a professional career than it is for women.	Mas1	0.647	0.777	0.468
	Men usually solve problems with logical analysis; women usually solve problems with intuition.	Mas2	0.751		
	Solving difficult problems usually requires an active forcible approach which is typical of men.	Mas3	0.767		
	There are some jobs that a man can always do.	Mas4	0.73		
Uncertainty	It is important to have instructions spelt out in detail so that I always know what I'm expected to do.	UAI1	0.671	0.923	0.706
	It is important to closely follow instructions and procedures.	UAI2	0.844		
	Standardised work procedures are helpful.	UAI3	0.886		
	Rules/regulations are important because they inform of what is expected of me.	UAI4	0.863		
	Instructions for operations are important.	UAI5	0.891		
Power Distance	People in higher positions should make most decisions without consulting the people in lower positions.	PDI1	0.812	0.401	0.285
	People in higher positions should not ask the opinions of people in lower positions too frequently.	PDI2	0.831		
	People in higher positions should avoid social interactions with people in lower positions.	PDI3	0.666		
	People in higher positions should not delegate important tasks to people in lower positions.	PDI4	0.836		
	People in lower positions should not disagree with decisions made by people in higher positions.	PDI5	0.803		
Long-term	Careful management of money (thrift). Going on resolutely in spite of opposition (persistence).	LTO1	0.773	0.673	0.327
	Personal steadiness and stability. Long-term planning.	LTO2	0.707		
	Personal steadiness and stability.	LTO3	0.818		
	Long-term planning.	LTO4	0.862		
	Working hard for success in the future.	LTO5	0.768		

variance extracted (AVE) should be more than 0.5. CR stands for composite reliability

Table 4.10: The factor loading, AVE and CR values of attributes of online water monitoring system

Attributes	Questionaire	Items	Factor loading	CR	AVE
Durability and Quality	Can be used for long-term	daq1	0.588	0.731	0.48
	Easy Maintenance.	daq2	0.805		
	Resistant to water	daq3	0.667		
Product Functionality	The easiness in using the product.	pf1	0.876	0.881	0.712
	Have additional functions embedded in product.	pf2	0.788		
	Usefulness of the product functions.	pf3	0.865		
Product Price	The affordable price.	pp1	0.765	0.865	0.681
	Low cost for Maintenance.	pp2	0.884		
	Spare part can be obtained easily in the market.	pp3	0.823		

The average variance extracted (AVE) should be more than 0.5. CR stands for composite reliability (it should be greater than 0.7; for an exploratory investigation, 0.60 to 0.70 is acceptable).

4.2.5 Discriminant validity

The next stage was to confirm discriminant validity after establishing convergent validity. By empirical standards, discriminant validity refers to how distinct a construct is from other constructs (Hair et al. 2019). The discriminant validity was assessed using the HTMT critical threshold, which was set at 0.85 (Henseler, Ringle, and Sarstedt 2015). Table 4.11 shows the findings of the HTMT for cultural in Malaysia.

Table 4.11: Heterotrait-Monotrait Ratio (HTMT) for discriminant validity for culture preferences in Malaysia

	Collectivism	Long-term oriented	Masculinity	Power Distance	Uncertainty Avoidance
Collectivism	0.806				
Long-Term Orientation	0.113	0.572			
Masculinity	0.416	0.091	0.684		
Power Distance	0.245	0.048	0.226	0.534	
Uncertainty Avoidance	0.22	0.116	0.35	0.202	0.84

To show discriminant validity, the HTMT value should be less than 0.85

The HTMT value for cultural in Malaysia was found to be < 0.85 based on the estimated values provided in Table 4.11. As a result, it was confirmed that the discriminant validity critical threshold had been established. This indicates that the cultural dimensions construct was diverse or different from one another.

4.2.6 Formative Measurement Model

The formative measurement model was evaluated after the reflecting measures for convergent and discriminant validities were finished. Durability and quality, product functioning, and product price are the three constructs that make up formative measurement in the model. The VIF and the outside loading should be analyzed to evaluate the formative measurement. VIF should be less than 5, and formative measuring outer loading should be greater than 0.5 (Hair et al. 2019).

Table 4.12: The variance inflation factor (VIF) for cultural preferences in Malaysia

Durability and Quality	VIF	Product Functionality	VIF	Product Price	VIF
daq1	1.053	pf1	2.271	pp1	1.425
daq2	1.126	pf2	1.539	pp2	1.741
daq3	1.114	pf3	1.849	pp3	1.645

VIF greater than 5 indicates a collinearity problem.

All VIF values for the indications of durability and quality, product functionality, and product price were found to be less than 5, as shown in the table above. This means that there were no concerns with collinearity in Malaysian cultural data.

4.2.7 Structural Modelling

Following the completion of the VIF assessments, the next stage was to determine the connections between the five cultural value dimensions constructs and the construct of customer preferences for green products. For the Indonesian and Malaysian data, the outer

loadings of the constructs of durability and quality, product functioning, and product pricing, as well as the linkages of the five cultural value dimensions, appear to be weak. The repeated indicators of the formative-formative measurements for the constructions of appearance, functionality, and price features may be the cause of these. The formative-formative and reflective-formative assessments in the HCM, according to (Hair et al. 2019), may result in a minor loading and significant association. To address this problem, a two-stage HCM analysis can be carried out, with the values of the latent variable scores of the construct measurements being extracted and the constructs being transformed into new indicators (Hair et al. 2019).

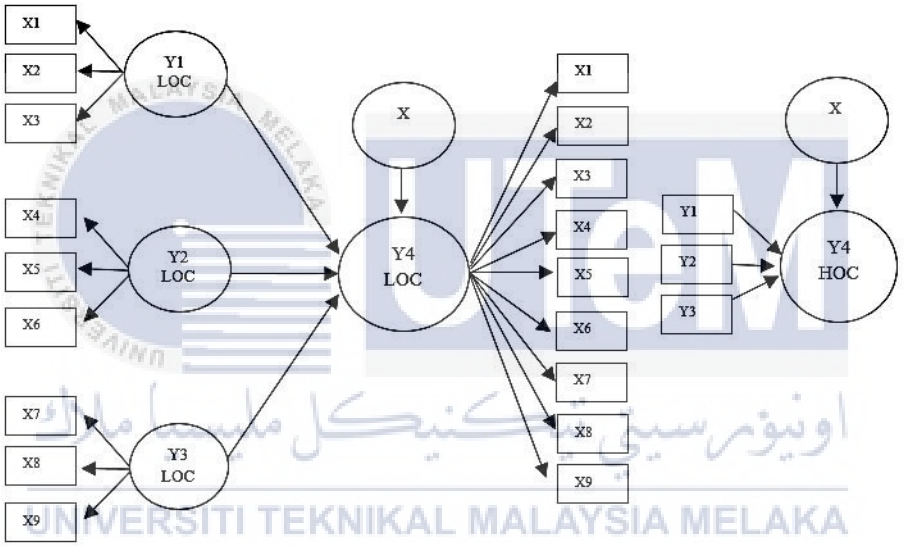

Figure 4.2: The two steps of analysis in HCM. Using the latent variable scores and constructs can be translated into new indicators

The constructs of appearance, functionality, and price features, as illustrated in Figure 4.2 on the explanation of the two-stage analysis, must be turned into new indicators, as manifest variables in the first stage, by applying the extracted latent variable scores of each construct. Following the conversion of these three constructs into new indicators, the next stage was to determine the linkages between the five cultural value dimensions that were linked to the construct of water monitoring system preferences. The t-value can be used to determine the significance of the associations. The conventional criterion for determining the significance of a coefficient is the t-value. It was suggested that the t-values be evaluated using

bootstrapping with 500 sub-samples. Figure 4.3 depicts the relationship between the cultural value dimension and the characteristic on online water monitoring systems for cultural data in Malaysia after using latent variable.

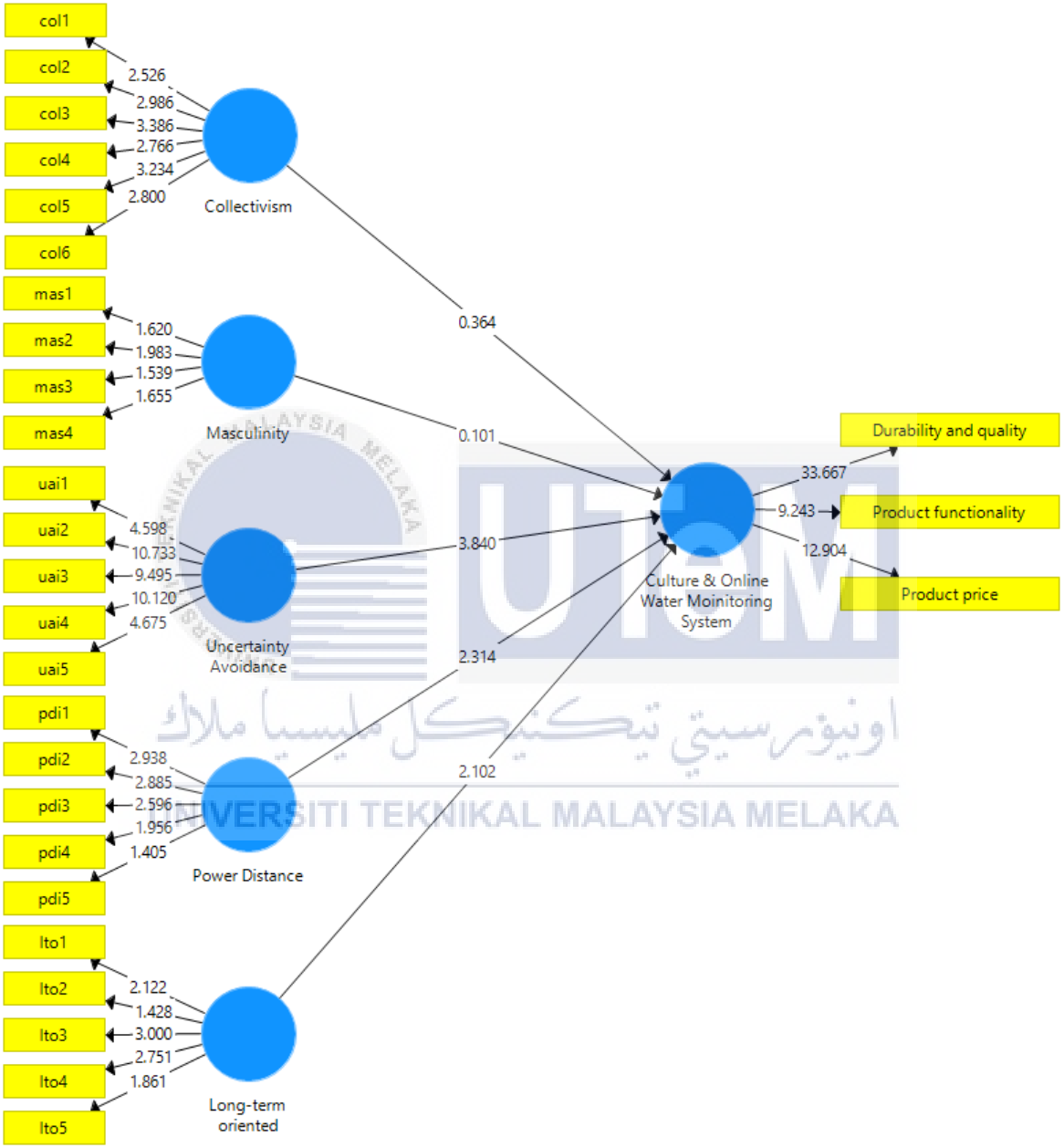

Figure 4.3: Structural modeling computation for cultural preferences in Malaysia after using latent variable

Table 4.13: Results of the structural equation model between Culture Value and Online Water Monitoring System

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Result
Collectivism -> Online Water Monitoring System	0.047	0.05	0.129	0.364	0.716	Not supported
Long-term oriented -> Online Water Monitoring System	0.204	0.211	0.097	2.102**	0.036	Supported
Masculinity -> Online Water Monitoring System	-0.012	0.026	0.118	0.101	0.92	Not supported
Power Distance -> Online Water Monitoring System	-0.263	-0.272	0.114	2.314**	0.021	Supported
Uncertainty Avoidance -> Water Monitoring System	0.321	0.296	0.084	3.84*	0	Supported

*$p< 0.01$, **$p< 0.05$, ***$p< 0.1$

According to Table 4.13, uncertainty avoidance ($t = 3.84$, $p < 0.01$), power distance ($t = 2.314$, $p < 0.01$) and long-term orientation ($t = 2.102$, $p < 0.01$), have significant influence on customer preferences for online water monitoring system products for Malaysian customers, where collectivism and masculinity have no significant influence on customer preferences.

4.3 Overview of Result

The links between the five cultural value influences in Malaysia and consumer preferences on the attributes of online water monitoring systems have been discovered. The purpose of this chapter is to discuss the findings of the five cultural value dimensions influences on online water monitoring characteristic.

4.3.1 Identifying Preferences on Online Water Monitoring System

The conventional attributes of online water monitoring system are largely influenced by cultural is ranked up from the durability and quality of product. Secondly, the product price, and lastly product functionality. These attributes were largely influenced by cultural values when it came to product choosing.

Table 4.14: Attributes influenced by cultural values with ranks

	Indicator	Customer Preferences on Online Water Monitoring System	Outer Weight
1	daq2	Easy Maintenance.	0.601
2	pp2	Low cost for Maintenance.	0.486
3	pf3	Usefulness of the product functions.	0.47
4	daq3	Resistant to water	0.419
5	daq1	Can be used for long-term	0.402
6	pf2	Have additional functions embedded in product.	0.384
7	pp3	Spare part can be obtained easily in the market.	0.373
8	pp1	The affordable price.	0.345
9	pf1	The easiness in using the product.	0.332

Outer weight with high values has more influences towards the conventional attributes.

According to the Table 4.14, the most preferred characteristic of the online water monitoring system is easy maintenance, low cost for maintenance, usefulness of the product functions, resistant to water, can be used for long-term, have additional functions embedded in product, spare part can be obtained easily in the market, the affordable price and lastly, the easiness in using the product.

4.3.2 The Identified Cultural Value Influences

According to the literature, the studies have been conducted to determine the influences of cultural values on customer choices. There are there of culture value that have significant influences based on customer preferences. The first is, uncertainty avoidance.

Secondly, long-term orientation and lastly, power distance which have significant influence on customer preferences.

4.3.2.1 Uncertainty Avoidance

Uncertainty avoidance has significant influence towards the consumers in Malaysia, which implies Malaysian consumers dislike the uncertainty when choosing the online water monitoring system product. The most preferred online water monitoring system attributes is the durability and quality of product. High uncertainty avoidance is characterised by the use of formality in interactions with others, reliance on codified policies and procedures, apparent opposition to change, and intolerance of unconventional methods. People from high-uncertainty-avoidance societies also have higher levels of stress and anxiety. These people place a high value on control, thus having a fixed structure in every aspect of their lives is beneficial. They are better able to define what they believe in and how they act when they employ tight guidelines. They are apprehensive about developing new ideas, so they only take chances that they are confident will pay off. In high UA, older people are both respected and feared. When youngsters are taught their culture's beliefs, they are unable to question them.

4.3.2.2 Power distance

Power relationships are paternalistic and authoritarian, with centralised authority; there is a large gap or emotional distance between persons at different levels of the hierarchy. There is a great deal of reliance (also known as counter-dependence) on those in positions of power. Subordinates are willing to accept their inferior positions in the workplace, while superiors may not insist on broad participation in decision-making. Autocratic leadership is common in higher PDI cultures, which means subordinates are less likely to approach and contradict their bosses directly.

4.3.2.3 Long-term orientation

This dimension connects the acts or problems of the past with those of the present and future. A lesser degree (short-term) of this indicator suggests that traditions are respected and upheld, and that steadfastness is prized. Adaptation and contextual, pragmatic problem-solving are seen as a need in societies with a high degree in this index (long-term). Short-term oriented poor countries frequently have little to no economic development, but long-term oriented countries continue to thrive and prosper.

4.4 Development of Prototype

4.4.1 Project Prototype

The project uses an NodeMCU ESP8266 and a water flow sensor to create an IoT-based water flow meter. The 0.96″ OLED Display shows the water flow rate and total volume. After that, connect the device to the IoT Server. The data on water flow rate and volume will be transferred to ThingSpeak Server, where it may be viewed and monitored from anywhere in the world.

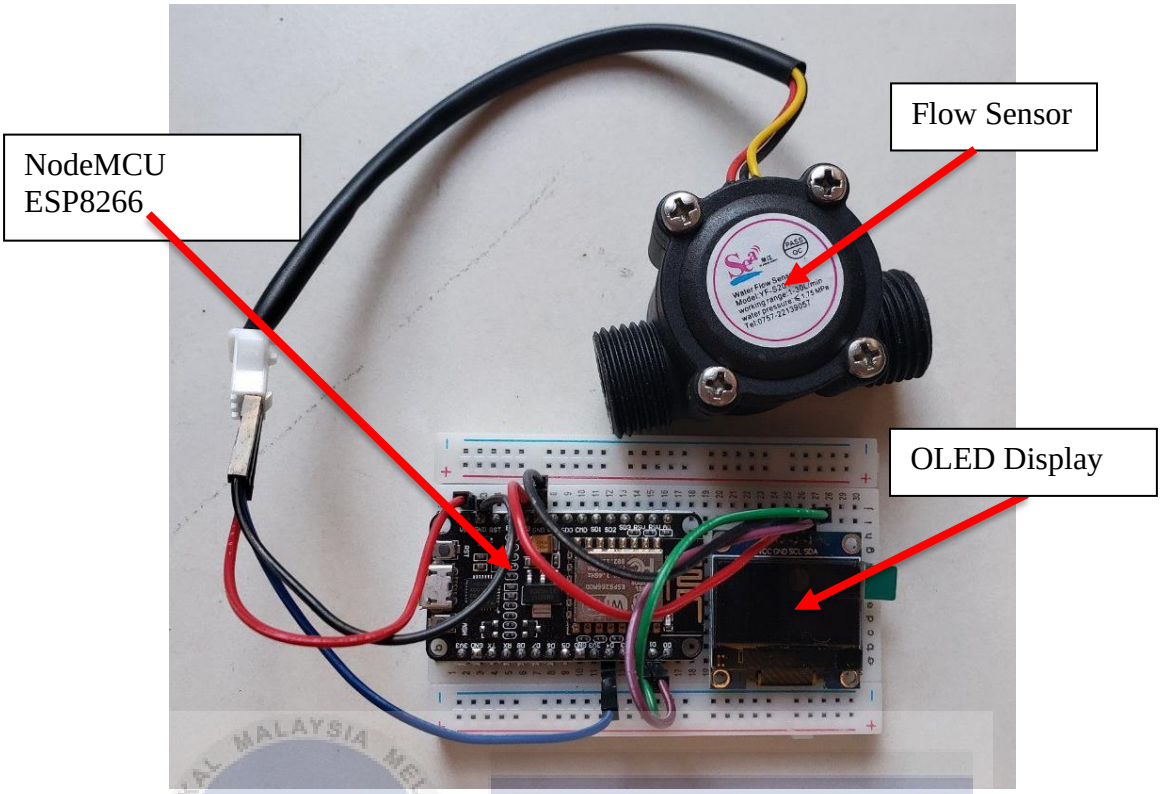

Figure 4.4: Hardware Prototype on breadboard

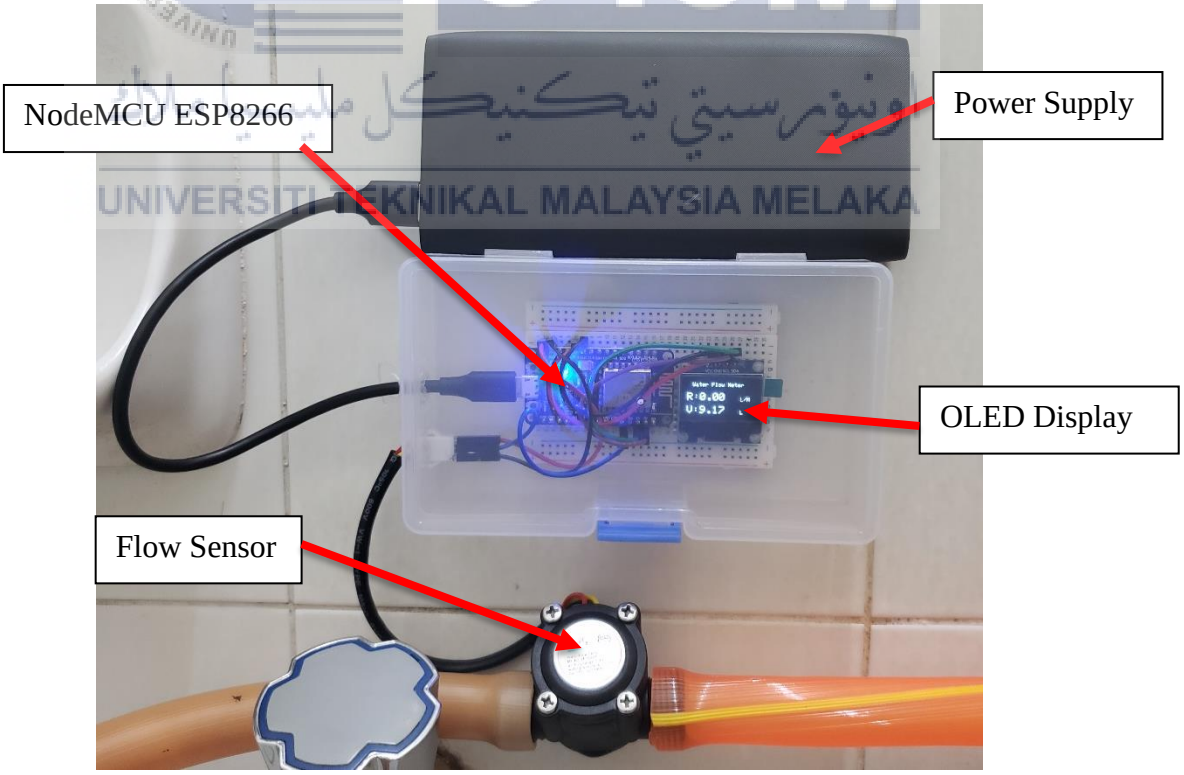

Figure 4.5: Hardware Prototype front view

Figure 4.4 show the component that used in this project of water monitoring system device for measuring flow rate of water. There consists of four main component hardware controlling, displaying, measuring sensor, and transmitting data (IoT). The NodeMCU act as the main controller in the system of measuring the turbidity, Wi-Fi module that built with NodeMCU is ESP8266 that used to transmit the data through the Internet (IoT), Liquid Crystal Display (I2C LCD) as the screen that display the data value that used to measure the flow rate of the water.

4.4.2 Prototype Circuit Diagram and Connection

The design circuit of this project are shown in Figure 4.6, this circuit shows the input and output from this project. Water Flow Sensor is a digital sensor that connected to any of the ESP8266's digital pins. It connects to GPIO2, which is D4 in this prototype. The sensor is powered by 5V and linked to the ESP8266's Vin. The SDA and SCL pins of the OLED Display are linked to D2 and D1 of the ESP8266, respectively. Because the OLED Display operates at 3.3V, it will be linked to the NodeMCU's 3.3V pin.

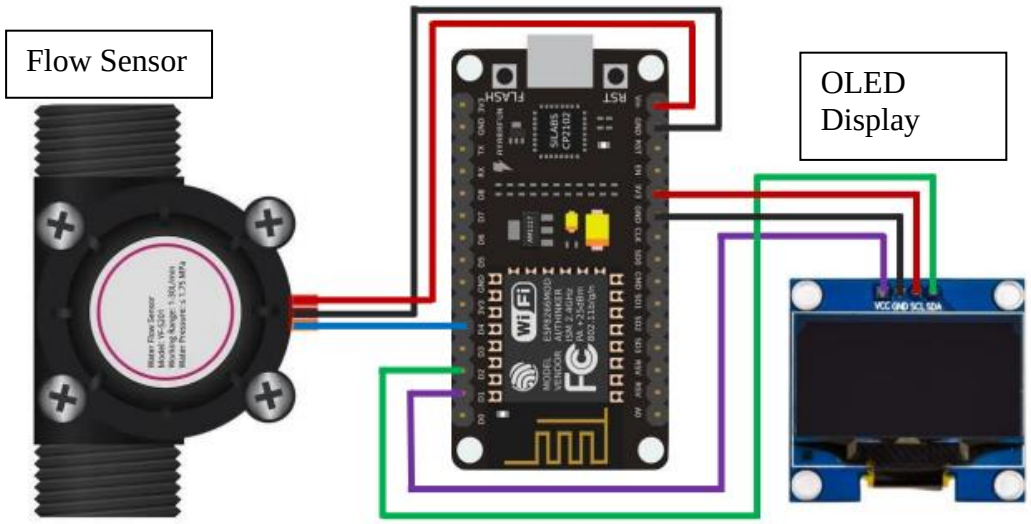

Figure 4.6: Circuit of Smart Water Monitoring System

4.4.3 Coding Prototype

The inputs and output components for this smart water monitoring system were NodeMCU built with ESP8266, water flow sensor and OLED display. The program used in this system which was Arduino Software (IDE) are called sketches.

4.4.3.1 IDE sketches

The sketches are created with a text editor and saved as files as the *ino extension*. Cutting and pasting, as well as searching/replacing text, are all available in the editor. The message section indicates faults and provides feedback while storing and exporting. The Arduino Software (IDE) outputs text to the console, which includes detailed error messages and other information. The configured board and serial port are displayed in the window's bottom righthand corner. You may validate and upload programmers, generate, open, and save sketches, and open the serial monitor using the toolbar buttons. In Figure 4.7 is the part of the whole coding in IDE. The whole coding will be found in the appendix.

WaterFlow

```
#include <ESP8266WiFi.h>
#include <SPI.h>
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>

#define SCREEN_WIDTH 128    // OLED display width, in pixels
#define SCREEN_HEIGHT 64    // OLED display height, in pixels
#define OLED_RESET -1       // Reset pin # (or -1 if sharing Arduino reset pin)

Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, OLED_RESET);

String apiKey = "QPH0TMWUNFGNYUMY"; // Enter your Write API key from ThingSpeak

const char* ssid     = "Galaxy S9";     // The SSID (name) of the Wi-Fi network you want to connect to
const char* password = "qwertyuiop";     // The password of the Wi-Fi network

const char* server = "api.thingspeak.com";

#define LED_BUILTIN 16
#define SENSOR  2

long currentMillis = 0;
long previousMillis = 0;
int interval = 1000;
boolean ledState = LOW;
float calibrationFactor = 4.5;
volatile byte pulseCount;
byte pulse1Sec = 0;
float flowRate;
unsigned long flowMilliLitres;
```

Figure 4.7:Part of Project Coding in IDE

4.5 Project Output

For this project, all the data collected are send and will be plotted to ThingSpeak database platform fields. Meanwhile, the data collected by NodeMCU are also displayed at the display at serial monitor COM5. The data read by sensors and what are been retrieve in ThingSpeak database. The data read by NodeMCU are collected for about few minutes.

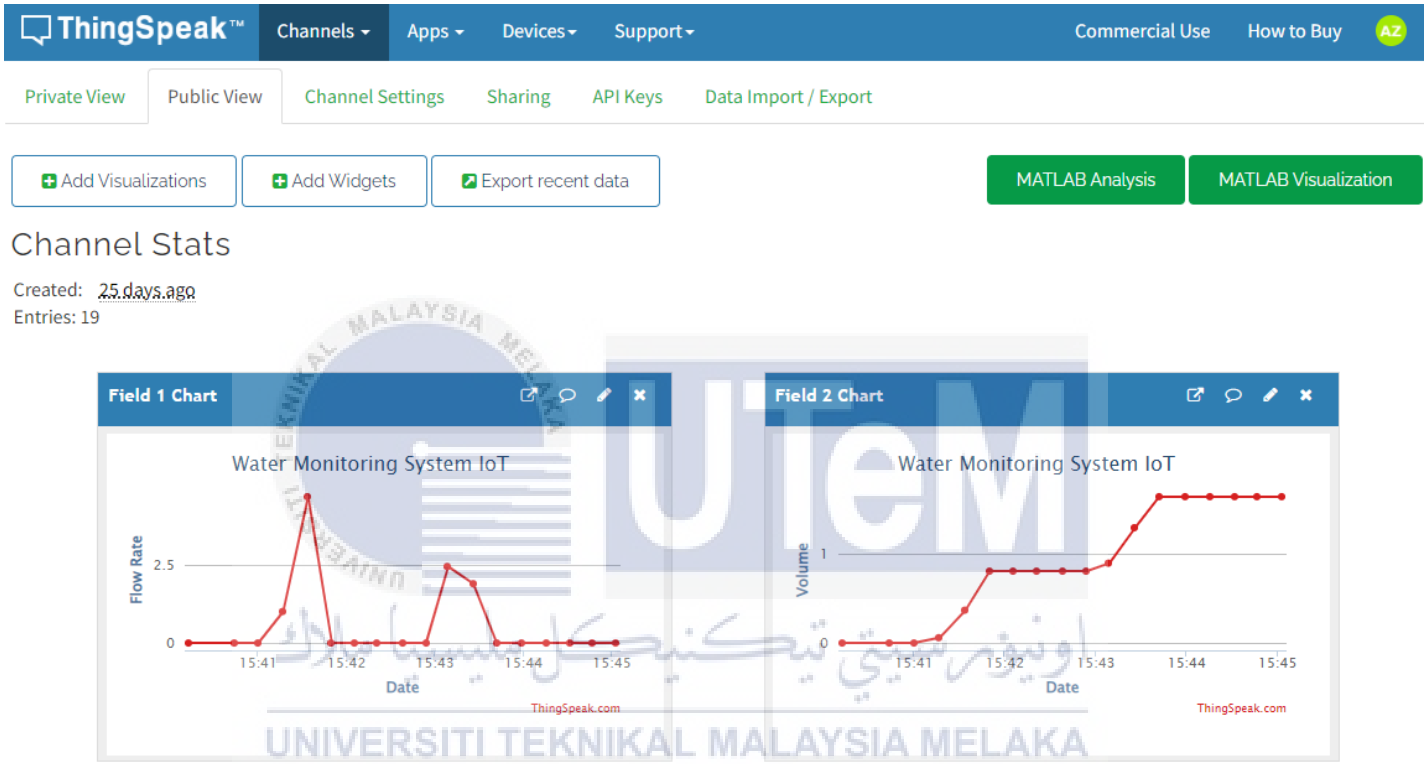

Figure 4.8: The graph shows the data send to ThingSpeak

Figure 4.9: ThingView Free Application on smartphone

The different of both display data is time interval, time interval of each data display at serial monitor COM5 a is 1 seconds and the time interval of the data sent to ThingSpeak is 15 seconds. This is because the data collected will display at serial monitor are been set to 1 seconds when sensor read each of the data. But for ThingSpeak, the minimum data sent are limited to 15 seconds because the account are free. The paid user has an advance setup which is the paid user can set the minimum time as user want.

Table shown in Table 4.2.4.1, will compared the data sent to ThingSpeak and data display at the IDE serial monitor COM5. The graphs below will determine whether there is any data lost or not. Furthermore, it will show the capabilities of ThingSpeak and the graphs will make the user easy to analysis all their data.

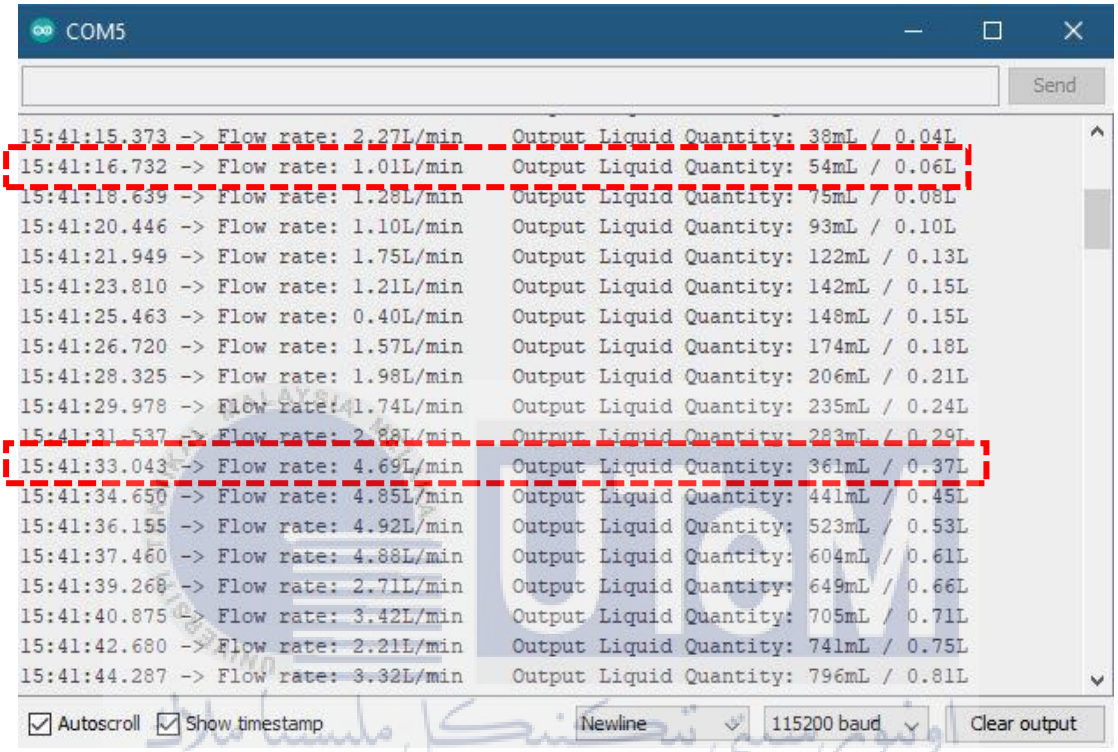

Figure 4.10: The data display at the IDE serial monitor COM5 every 1 seconds

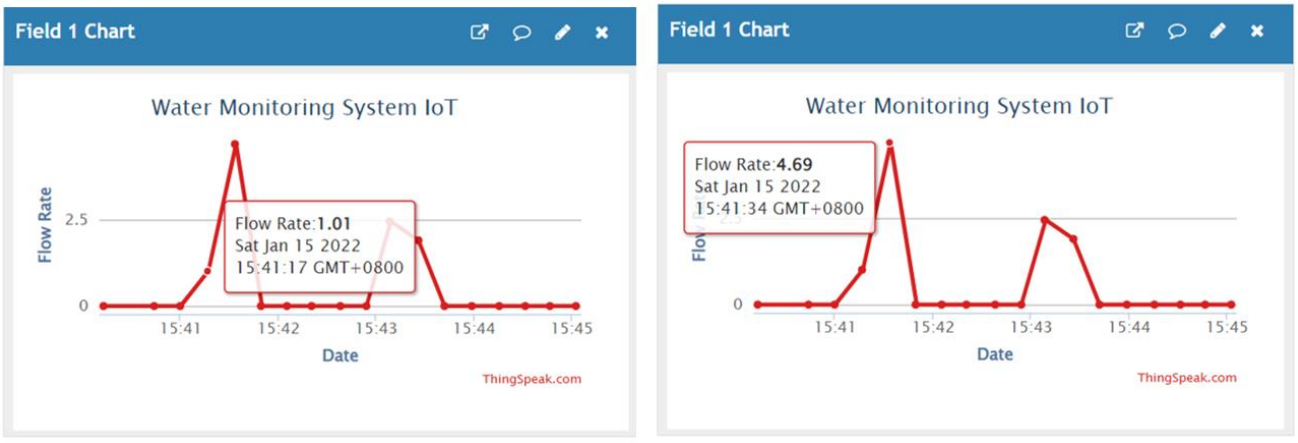

Figure 4.11: Graph shows that ThingSpeak receive the data of flow rate every 15 seconds

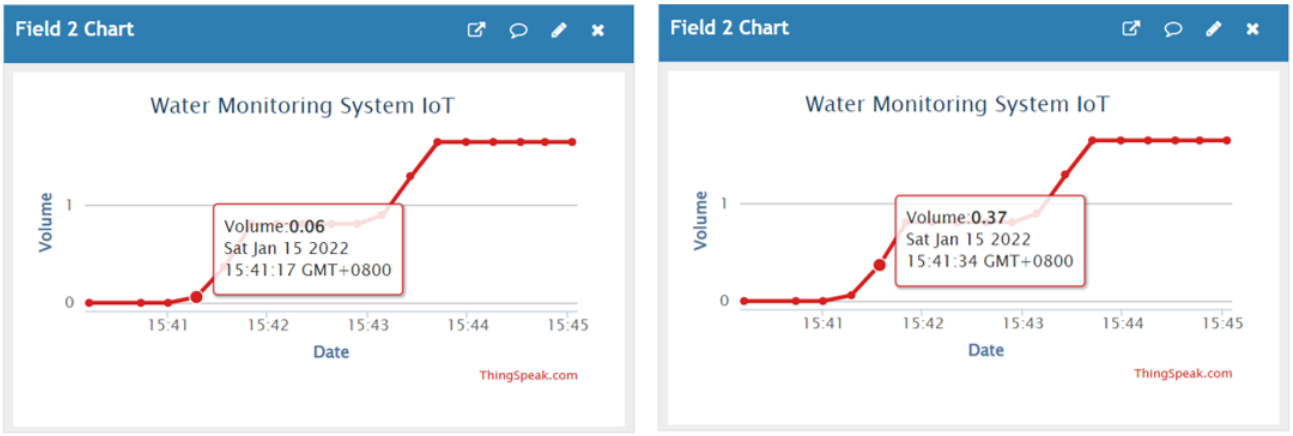

Figure 4.12: Graph shows that ThingSpeak receive the data of volume every 15 seconds

Both graphs show that data on ThingSpeak and serial monitor COM5 are the same because it been measured as the NodeMCU ESP8266 control and monitor the time. There are no any data lost, but there are can have a few wrong values that been display on terminal and ThingSpeak database due to some errors on the sensor.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter is served to present the conclusion of the research. This includes the achievements of the research objectives, the contributions of the research to the theory, and practices and the novelties of the research. The achievements of research objectives are presented in this section. The limitations of the research and the direction for future researchers are also described in the last section of this chapter.

5.2 Conclusion

The purpose of this study was to investigate the influence of cultural values on the online water monitoring system in ablution. To attain the research aim, it was necessary to complete the three research objectives. The goal of this study was to create a guideline for incorporating cultural value impacts into the online water monitoring system. In a point of view, the overall of this project is successfully achieved all the objectives and the target that have been made. The overall of this report described the effective elements needed for the water monitoring system. The system for this project was successfully develop by using NodeMCU ESP8266 as microcontroller and Wi-Fi. Each of the functionality of the system had been analyse based on the observing of water flow. By using the online water monitoring system based on IoT, the water consumption can be predicted and cost of wasting water in ablution can be prevented and this system can be used to detect any leaking water in the tank which can be very useful in control the water consumption. Besides that, this system also allow user to monitor their water consumption through ThingSpeak server with their smartphone or laptop.

5.3 Recommendations

There are several methods and ideas can be added into this project. Firstly, this project is only focus on one parameter which is water flow. In water, there are many of parameters included such as pH, oxidation of water, temperature, conductivity and others. Then, adding some more of parameters sensor can make the device is more precise and accurate when to measure the water comsumptions and also can be use to calculate other parameter beside than water flow.

Next, this project also can be modified by changing the application that use in monitor the water or register as the membership. The ThingSpeak account that currenly use in this prototype is free and the data upload to ThingSpeak server is 15s. Although, changing the application to Bynk also can help to get fast data upload.

Lastly, based on the findings of this study, it is highly recommended that to incorporate the cultural value consideration when designing any product. It allows to explore in more detail about the customer preferences, as a basis to develop the product that use culture as the preferences.

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APPENDICES

APPENDIX A : Gantt Chart PSM 1

Gantt Chart for PSM 1																	
No	**Project Task**	**Plan/Actual**	**Week**														
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	PSM 1 briefing	Plan															
		Actual															
2	Topic discussion with the supervisor	Plan															
		Actual															
3	Discuss problem statement and objective chapter 1	Plan															
		Actual															
4	Writing Chapter 1	Plan															
		Actual															
5	Drafting and writing Chapter 2	Plan															
		Actual															
6	Methodology research and writing Chapter 3	Plan															
		Actual															
7	Submission of first draft PSM 1	Plan															
		Actual															
8	Chapter correction	Plan															
		Actual															
9	Submission of second draft PSM 1	Plan															
		Actual															
10	Preparation and presentation of PSM 1	Plan															
		Actual															

APPENDIX B : Gantt Chart PSM 2

Gantt Chart for PSM 2																
No	**Project Task**	**Plan/Actual**	**Week**													
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	PSM 2 briefing	Plan															
		Actual															
2	Collect data result and make analysis.	Plan															
		Actual															
3	Drafting data analysis result.	Plan															
		Actual															
4	Start writing Chapter 4.	Plan															
		Actual															
5	Data analysis result and discussion	Plan															
		Actual															
6	Writing Chapter 4	Plan															
		Actual															
7	Writing Chapter 5	Plan															
		Actual															
8	Submission of full report.	Plan															
		Actual															
9	Finalize the connection of full report.	Plan															
		Actual															
10	Preparation and presentation of PSM 2.	Plan															
		Actual															

APPENDIX C: Survey Questionaire Water monitoring System Online

A STUDY ON:

THE DEVELOPMENT OF ONLINE MONITORING SYSTEM FOR WATER CONSUMPTION IN ABLUTION ACTIVITY CONSIDERING MALAYSIAN CULTURAL PREFERENCES

Dear respondents,

We conduct a study on "The development of online monitoring system for water consumption in ablution activity considering Malaysian cultural preferences". We would appreciate it if you were able to complete the questionnaire below.

Thank you very much for answering our questionnaire.

Sincerely,

Muhamad Azfar Bin Mohd Zulkifli,BMMP

Dr. Ihwan Ghazali, Supervisor

Faculty of Mechanical and Manufacturing Engineering Technology

QUESTIONNAIRE

PART A: RESPONDENT'S BACKGROUND

Answer each question by tick (✓) in the corresponding box.

1. Gender
   - ☐ Male
   - ☐ Female

2. Age
   - ☐ 16 - 24
   - ☐ 25 - 34
   - ☐ 35 - 44
   - ☐ 45 - 54
   - ☐ 55 - 64
   - ☐ 65 – over

3. Race
   - ☐ Malay ☐ Chinese
   - ☐ Indian ☐ Others

4. Educational Qualifications
   - ☐ PMR/PT3 ☐ SPM ☐ STPM/Matriculation/A-Level
   - ☐ Diploma ☐ Degree ☐ Master/PHD

PART B: DURABILITY AND QUALITY

You will be asked about several aspects of "**durability and quality**" in this section. Place a tick (ü) in the corresponding box to show how much you agree with each of the statements of "**durability and quality**". The number will be on a range of 1 to 5, with 1 indicating "strongly disagree" and 5 indicating "strongly agree".

	Durability and Quality	1	2	3	4	5
1.	Can be used for long-term					
2.	Easy Maintenance.					
3.	Resistant to water					

PART C: PRODUCT FUNCTIONALITY

You will be asked about several aspects of "**product functionality**" in this section. Place a tick (ü) in the corresponding box to show how much you agree with each of the statements of "**product functionality**". The number will be on a range of 1 to 5, with 1 indicating "strongly disagree" and 5 indicating "strongly agree".

	Product Functionality	1	2	3	4	5
1.	The easiness in using the product.					
2.	Have additional functions embedded in product.					
3.	Usefulness of the product functions.					

PART D: PRODUCT PRICE

You will be asked about several aspects of "**product price**" in this section. Place a tick (ü) in the corresponding box to show how much you agree with each of the statements of "**product price**". The number will be on a range of 1 to 5, with 1 indicating "strongly disagree" and 5 indicating "strongly agree".

	Product Price	1	2	3	4	5
1.	The affordable price.					
2.	Low cost for Maintenance.					
3.	Spare part can be obtained easily in the market.					

APPENDIX D: RAW DATA

CULTURAL VALUE DATA

col 1	col 2	col 3	col 4	col 5	col 6	mas 1	mas 2	mas 3	mas 4	uai 1	uai 2	uai 3	uai 4	uai 5	pdi 1	pdi 2	pdi 3	pdi 4	pdi 5	lto 1	lto 2	lto 3	lto 4	lto 5
6	8	6	7	7	4	0	7	5	9	10	8	8	8	8	9	3	4	2	1	10	5	7	5	2
10	10	10	6	9	9	1	9	10	10	9	10	10	10	10	6	6	6	6	9	9	1	2	3	4
5	2	3	3	3	7	0	2	2	4	2	4	4	7	4	5	2	3	3	3	7	7	2	2	3
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3	2	2	2	2	1	2	6	2	7	2	2	3	3	3	9	2	2	2	2	9	9	6	2	9
3	4	4	5	6	5	4	4	5	2	5	6	6	4	4	3	4	4	4	2	3	4	2	5	5
7	8	8	9	8	8	9	7	10	6	3	5	4	3	3	0	9	2	9	3	2	5	8	6	9
3	5	4	6	5	3	9	5	4	6	8	8	8	8	8	9	2	1	5	9	6	6	8	8	1
4	4	7	7	7	7	5	9	5	8	5	7	5	9	9	5	5	5	5	2	4	4	10	1	3
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7	7	6	6	5	4	6	8	6	9	6	8	8	8	8	1	9	8	9	4	8	8	9	5	1
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8	8	8	8	8	5	0	9	10	10	10	10	10	10	10	5	6	9	4	9	9	3	3	0	3
6	6	5	5	6	6	7	5	5	7	7	7	7	7	8	3	9	7	6	6	5	6	1	4	8
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	3	4	2	7	7	5	6	4	9	8
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5	5	5	5	5	5	0	0	0	0	10	10	10	10	10	3	4	8	8	8	8	4	4	9	2

2	1	0	1	5	3	6	6	5	8	3	5	10	10	10	9	9	9	5	5	6	9	4	6	10
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5	6	5	5	4	4	0	9	1	0	0	3	7	5	8	0	0	2	1	1	8	9	4	4	10
7	7	7	7	7	7	0	3	2	7	6	3	6	6	6	9	0	0	0	0	4	7	7	7	8
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7	8	7	8	8	7	10	8	8	8	7	7	8	8	8	8	7	9	8	5	5	2	6	7	8
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5	5	5	5	4	4	8	6	6	7	7	8	8	7	8	3	4	0	5	4	6	5	5	6	6
5	10	7	7	7	7	10	5	5	10	10	7	10	7	10	9	0	0	0	3	3	7	7	7	10
3	6	7	6	10	6	6	0	2	6	2	5	5	5	5	3	2	0	2	0	10	5	3	4	8
6	6	6	5	9	6	2	2	5	7	8	9	9	9	9	6	8	0	6	2	8	6	6	3	7
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7	10	6	0	10	1	7	5	5	2	10	9	10	9	10	4	5	3	8	2	9	1	9	9	9
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0	3	5	2	1	0	0	9	1	2	2	8	8	8	8	9	9	0	0	9	9	9	9	6	9
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QUESTIONAIRE ONLINE WATER MONITORING SYSTEM DATA

Gender	Age	Race	Religion	Educational Level	daq1	daq2	daq3	pf1	pf2	pf3	pp1	pp2	pp3
2	2	1	1	5	4	4	4	4	4	4	5	4	4
1	2	1	1	5	5	4	4	4	5	4	5	5	4
2	2	1	1	5	5	4	5	5	5	4	4	5	4
1	3	1	1	4	5	4	5	5	5	5	5	4	4
1	2	1	1	4	5	4	4	5	5	5	5	4	4
1	2	1	1	5	5	4	4	5	5	4	5	5	5
2	1	1	1	5	5	4	5	5	4	5	5	4	4
1	1	1	1	5	4	5	5	5	4	5	5	5	4
1	2	1	1	5	4	5	3	4	3	4	5	5	5
1	2	1	1	5	4	4	4	4	5	3	4	5	5
1	2	1	1	5	5	5	5	5	5	5	5	5	5
2	1	1	1	5	5	4	5	5	4	5	5	5	5
2	1	1	1	5	5	4	3	5	1	5	4	5	5
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1	1	1	1	5	4	4	2	5	4	4	2	4	4
1	1	1	1	5	5	5	5	5	5	5	5	5	5
1	2	1	1	6	4	4	4	5	5	4	3	4	3
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1	1	1	1	5	5	5	5	5	5	5	5	5	5
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1	1	1	1	4	5	5	4	4	5	5	5	5	4

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2	1	1	1	4	5	5	5	5	5	5	5	5	5
2	2	1	1	5	5	5	5	5	5	5	5	5	5
2	2	1	1	5	5	5	5	5	5	5	5	5	5
2	1	1	1	4	5	5	5	5	5	5	5	5	5
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1	2	1	1	5	5	5	5	5	5	5	5	5	5
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1	1	1	1	4	5	5	3	4	4	5	4	5	5
1	2	1	1	5	5	5	5	5	5	5	5	5	5

APPENDIX E: Coding Arduino

```
#include <ESP8266WiFi.h>
#include <SPI.h>
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>

#define SCREEN_WIDTH 128    // OLED display width, in pixels
#define SCREEN_HEIGHT 64    // OLED display height, in pixels
#define OLED_RESET -1       // Reset pin # (or -1 if sharing Arduino reset pin)

Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire,
OLED_RESET);

String apiKey = "QPH0TMWUNFGNYUMY"; // Enter your Write API key from
ThingSpeak

const char* ssid     = "RumahSewaGG";     // The SSID (name) of the Wi-Fi network you
want to connect to
const char* password = "Gumpalan2022";     // The password of the Wi-Fi network

const char* server = "api.thingspeak.com";

#define LED_BUILTIN 16
#define SENSOR  2

long currentMillis = 0;
long previousMillis = 0;
int interval = 1000;
boolean ledState = LOW;
float calibrationFactor = 4.5;
volatile byte pulseCount;
byte pulse1Sec = 0;
float flowRate;
unsigned long flowMilliLitres;
unsigned int totalMilliLitres;
float flowLitres;
float totalLitres;

void IRAM_ATTR pulseCounter()
{
  pulseCount++;
}

WiFiClient client;

void setup()
{
```

```
  Serial.begin(115200);
  WiFi.begin(ssid, password);             // Connect to the network
  display.begin(SSD1306_SWITCHCAPVCC, 0x3C); //initialize with the I2C addr 0x3C
(128x64)
  display.clearDisplay();
  delay(10);

  pinMode(LED_BUILTIN, OUTPUT);
  pinMode(SENSOR, INPUT_PULLUP);

  pulseCount = 0;
  flowRate = 0.0;
  flowMilliLitres = 0;
  totalMilliLitres = 0;
  previousMillis = 0;

  attachInterrupt(digitalPinToInterrupt(SENSOR), pulseCounter, FALLING);
}

void loop()
{
  currentMillis = millis();
  if (currentMillis - previousMillis > interval)
  {

    pulse1Sec = pulseCount;
    pulseCount = 0;

    // Because this loop may not complete in exactly 1 second intervals we calculate
    // the number of milliseconds that have passed since the last execution and use
    // that to scale the output. We also apply the calibrationFactor to scale the output
    // based on the number of pulses per second per units of measure (litres/minute in
    // this case) coming from the sensor.
    flowRate = ((1000.0 / (millis() - previousMillis)) * pulse1Sec) / calibrationFactor;
    previousMillis = millis();

    // Divide the flow rate in litres/minute by 60 to determine how many litres have
    // passed through the sensor in this 1 second interval, then multiply by 1000 to
    // convert to millilitres.
    flowMilliLitres = (flowRate / 60) * 1000;
    flowLitres = (flowRate / 60);

    // Add the millilitres passed in this second to the cumulative total
    totalMilliLitres += flowMilliLitres;
    totalLitres += flowLitres;

    // Print the flow rate for this second in litres / minute
    Serial.print("Flow rate: ");
    Serial.print(float(flowRate));  // Print the integer part of the variable
    Serial.print("L/min");
```

```
  Serial.print("\t");       // Print tab space

  display.clearDisplay();

  display.setCursor(10, 0); //oled display
  display.setTextSize(1);
  display.setTextColor(WHITE);
  display.print("Water Flow Meter");

  display.setCursor(0, 20); //oled display
  display.setTextSize(2);
  display.setTextColor(WHITE);
  display.print("R:");
  display.print(float(flowRate));
  display.setCursor(100, 28); //oled display
  display.setTextSize(1);
  display.print("L/M");

  // Print the cumulative total of litres flowed since starting
  Serial.print("Output Liquid Quantity: ");
  Serial.print(totalMilliLitres);
  Serial.print("mL / ");
  Serial.print(totalLitres);
  Serial.println("L");

  display.setCursor(0, 45); //oled display
  display.setTextSize(2);
  display.setTextColor(WHITE);
  display.print("V:");
  display.print(totalLitres);
  display.setCursor(100, 53); //oled display
  display.setTextSize(1);
  display.print("L");
  display.display();
}

if (client.connect(server, 80)) // "184.106.153.149" or api.thingspeak.com
{
  String postStr = apiKey;
  postStr += "&field1=";
  postStr += String(float(flowRate));
  postStr += "&field2=";
  postStr += String(totalLitres);
  postStr += "\r\n\r\n";

  client.print("POST /update HTTP/1.1\n");
  client.print("Host: api.thingspeak.com\n");
  client.print("Connection: close\n");
  client.print("X-THINGSPEAKAPIKEY: " + apiKey + "\n");
  client.print("Content-Type: application/x-www-form-urlencoded\n");
```

```
    client.print("Content-Length: ");
    client.print(postStr.length());
    client.print("\n\n");
    client.print(postStr);

  }
  client.stop();
}
```

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA

TAJUK: **THE DEVELOPMENT OF ONLINE MONITORING SYSTEM FOR WATER CONSUMPTION IN ABLUTION ACTIVITY CONSIDERING MALAYSIA CULTURAL PREFERENCES**

SESI PENGAJIAN: **2020/21 Semester 1**

Saya **MUHAMMAD AZFAR BIN MOHD ZULKIFLI**

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Tarikh: 18 JANUARI 2022

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Tarikh (Date): 31 Januari 2021

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Nama pelajar: MUHAMMAD AZFAR BIN MOHD ZULKIFLI (B091810176)
Tajuk Tesis: THE DEVELOPMENT OF ONLINE MONITORING SYSTEM FOR WATER CONSUMPTION IN ABLUTION ACTIVITY CONSIDERING MALAYSIAN CULTURAL PREFERENCES.

3. Hal ini adalah kerana IANYA MERUPAKAN PROJEK YANG DITAJA OLEH SYARIKAT LUAR DAN HASIL KAJIANNYA ADALAH SULIT.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"
"KOMPETENSI TERAS KEGEMILANGAN"

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