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Design of Micro-Controlled Swimming Pool Water Quality Monitoring System with SMS Notification for Educational Purposes with Cost Analysis

Kathryn N. Purazo*, Jessa Mae Niña T. Paris, Jan Ilde S. Subaldo, Brian B. Bacal

Notre Dame of Tacurong College, the Philippines

*Correspondence: E-mail: kathnimp11@gmail.com

ABSTRACT

This study reported the design of a micro-controlled swimming pool water quality monitoring system with SMS notification, which can be used as a media for the teaching and learning process. We developed to measure and monitor the physical properties of pool water in terms of its pH level, turbidity, and temperature using different sensors to provide water monitoring quality control. As a sample, we showed the data gained from the swimming pools in Tacurong City and Lebak, Sultan Kudarat, the Philippines. A total of thirty-two respondents from the four swimming pools in Tacurong City and Lebak had gathered to participate in this study to evaluate its effectiveness in terms of accuracy in detecting water properties of swimming pools, sending notifications on the schedule of draining, and generating the summary reports of the swimming pool's water physical properties and schedules of water draining. We also explained the step-by-step design and cost analysis for making this apparatus. The findings of this study suggest the following: (1) to use additional water quality sensors such as microbiological and chemical water parameters that could be utilized with automatic pool monitoring systems, and (2) to have a smart pool chemical monitoring device that utilized water quality sensors that could be easily downloaded and installed on an Android device, and which utilized wireless technology and real-time notifications to monitor the pool water quality.

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1. INTRODUCTION

Water is one of the most important natural resources that has been given to humanity by nature. Water exists naturally in a variety of forms and locations throughout the world, including the atmosphere, the surface of the earth, beneath the ground, and in the oceans (Geetha et al., 2016). However, the rapid development of civilization, as well as the multitude of human activities, has accelerated the contamination of water supplies, which has ultimately resulted in the depletion of water resources. As a result, it is necessary to conduct water quality monitoring to detect any changes in water quality parameters over time to ensure the safety of drinking water in real-time (Gokulanathan et al., 2019).

Here, the purpose of this study was to design of micro-controlled swimming pool water quality monitoring system with SMS notification, which can be used as a media for the teaching and learning process. We developed to measure and monitor the physical properties of pool water in terms of its pH level, turbidity, and temperature using different sensors to provide water monitoring quality control. As a sample, we showed the data gained from the swimming pools in Tacurong City and Lebak, Sultan Kudarat, the Philippines.

2. METHODS

Specifically, the study aimed to:

- (i) Using pH level, temperature, and turbidity sensors, demonstrate and discuss the algorithms developed for monitoring the physical properties of water and notifying the user of the need to drain the water on a scheduled basis.
- (ii) Generate reports on the summary of the swimming pool's water physical properties and schedules of water draining.
- (iii) Test the developed system's level of effectiveness in terms of:
 - a. accuracy;
 - b. usefulness.
- (iv) Determine the significant difference among the physical properties of the water in the swimming pools of Lebak and Tacurong City in terms of pH level, temperature, and turbidity using the developed system.
- (v) Determine the significant relationship between the overall mean of the developed system's level of effectiveness and the swimming pools' water physical properties.

Research sampling is an important component of research because it is significant in terms of the results and findings that are obtained from it. This study employed complete enumeration or census where all owners and staff of four swimming pool resorts in Tacurong City and the Municipality of Lebak in Sultan Kudarat were measured to evaluate the effectiveness of the developed system.

Because it determines and evaluates the performance of the developed system, statistical treatment of data is extremely important in all research studies, regardless of the subject matter. To evaluate the effectiveness of the developed system in terms of accuracy and usefulness, mean, and standard deviation (SD) were used in this study. Additional statistical tests such as one-way Analysis of Variance (ANOVA) and Pearson r correlation were used to determine whether there was a statistically significant difference between the water's physical properties such as pH, turbidity, and temperature, and to determine if there was a relationship between the accuracy, usefulness, and water's physical properties of the swimming pools, respectively.

3. RESULTS AND DISCUSSION

3.1. Definition of terms

The following terms were defined both contextually and operationally to ensure that the study was thoroughly understood:

- (i) Accuracy – refers to the developed system’s capability to produce precise results in terms of temperature, pH level, and turbidity of the water in swimming pools and the generation of system reports.
- (ii) Arduino Mega board – is a microcontroller board based on the ATmega2560. The Arduino Mega is powered with a USB connection or an external power supply. Temperature, ultrasonic, pH, and Turbidity sensors are connected to the Arduino board. These sensors send the data to an Arduino board which is connected to the GSM module for sending this data to mobile as SMS.
- (iii) Database – is the storage of the generated daily and weekly report summary of the developed system.
- (iv) GSM Module – is used in this study for sending and receiving messages.
- (v) This GSM module requires a SIM card for sending information or data as SMS to mobile. This module is connected to Arduino.
- (vi) Local Area Network (LAN) – it is a computer network that connects the developed system from one computer to another to share files or data such as its daily and weekly reports.
- (vii) Microcontroller – is the device used to control the operation of the developed system.
- (viii) Reports – a compilation of the daily and weekly results of the developed system’s database queries that contain useful data on the water qualities parameter such as temperature, pH level, and turbidity of the water in swimming pools.
- (ix) Temperature sensor – is connected to the microcontroller which is used for the measurement of the temperature of water. The data provided by the temperature sensor is analyzed by a microcontroller and sent on mobile through a GSM modem.
- (x) Usefulness – refers to the fact that the developed system has the quality of being useful to the community.

3.2. Conceptual framework

The conceptual framework of the Micro-Controlled Swimming Pool Water Quality Monitoring System with SMS Notification is depicted in **Figure 1**. Microcontroller is shown with sensors directly connected to it. A water sample is used to measure the sensor parameters such as pH level, temperature, and turbidity. The Arduino Mega 2560 is in charge of the entire operation of the developed system. There are three (3) sensors attached to this microcontroller board which allows for greater flexibility in working with more memory space and processing power. The data on the pH level of water which are captured from the pH sensor are analyzed by the microcontroller using **Table 1**.

The pH level of swimming pool water is described in detail in **Table 1**. When it comes to water acidity, a pH level of seven (7) indicates that the swimming pool's water is neutral; anything higher than seven indicates that the water is alkaline, and anything lower than seven indicates that the water is acidic. When it comes to water acidity, a pH level of between 7 and 7.6 is considered ideal. Anyone who swims in pool water with a pH level higher than eight (8) is at risk of developing skin rashes, while water with a pH level lower than seven (7) can sting swimmers' eyes. Aside from the pH level, the developed system can also read and interpret the turbidity of the swimming pool water. The pool water treatment system should be capable of providing clarity of no more than 0.5 NTU in terms of water turbidity ([Nandiyanto](#)

et al., 2019). Finally, to determine whether the water in the swimming pool is too cold or too hot, the developed system tests the water at an ideal temperature between 26°C and 32°C. After the data has been gathered and analyzed, it is stored in the database of the developed system. Furthermore, to send information on the schedule of draining to the personnel in charge via SMS notification, the microcontroller is connected to the GSM module.

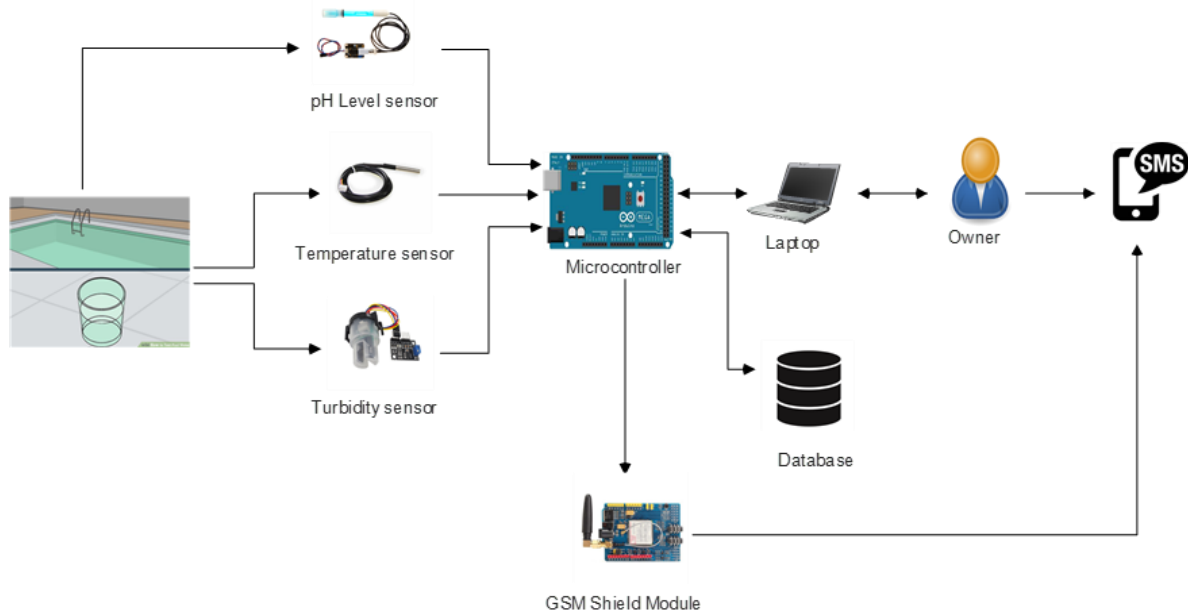


Figure 1. Conceptual framework of micro-controlled swimming pool water quality monitoring system with SMS notification.

Table 1. Description of pH level of swimming pool water. Data was obtained from <https://www.betterhealth.vic.gov.au/health/healthyliving/swimming-pools-waterquality#ph-level-in-swimming-pool-water> retrieved on March 2023.

pH Level	Description
<7.0	Acidic
7.0-7.6	Neutral
>7.0	Alkaline

The theoretical framework for a Micro-Controlled Swimming Pool Water Quality Monitoring System with SMS Notification is depicted in **Figure 2**. As shown in the diagram, the framework is divided into three sections: The Input, the Process, and the Output. The pH Level sensor, the temperature sensor, and the turbidity sensor are all used as input devices. A pH sensor is used to determine the acidity or alkalinity of water in a swimming pool by measuring the hydrogen ion concentration (pH level). Pure water has a pH value of 7. As a general rule, water with a pH less than 7 is considered acidic, and water with a pH greater than 7 is considered alkaline. As a pH sensor, the high-accuracy pH probe TL42 is used, which is a special glass refillable electrode (Pantjawati et al., 2020; Raam et al., 2019) with a high degree of precision. The structure of a pH sensor is depicted in **Figure 3**.

When the pH sensor is in use, it resembles an inverted rod made of glass and terminating in a "Glass membrane" at the tip. This membrane is filled with a buffer solution with a known pH (typically pH = 7) that has been prepared beforehand. The design of this electrode ensures a constant binding of positively charged hydrogen (H⁺) ions on the inside of the glass membrane, which results in a stable environment. Following submersion of the probe in the test solution, hydrogen ions in the test solution begin exchanging with other positively

charged ions on the glass membrane, creating an electrochemical potential across the membrane, which is fed to the electronic amplifier module, which measures and converts the potential between both electrodes to pH units (Raam *et al.*, 2019). Afterward, the temperature sensor is connected to an Arduino mega board or a microcontroller, which is used to monitor and record data about the water temperature in the pool. In turn, the data gathered by the temperature sensor is processed and analyzed by the microcontroller, which then sends an alert to the manager or owner's mobile phone through the use of the GSM module.

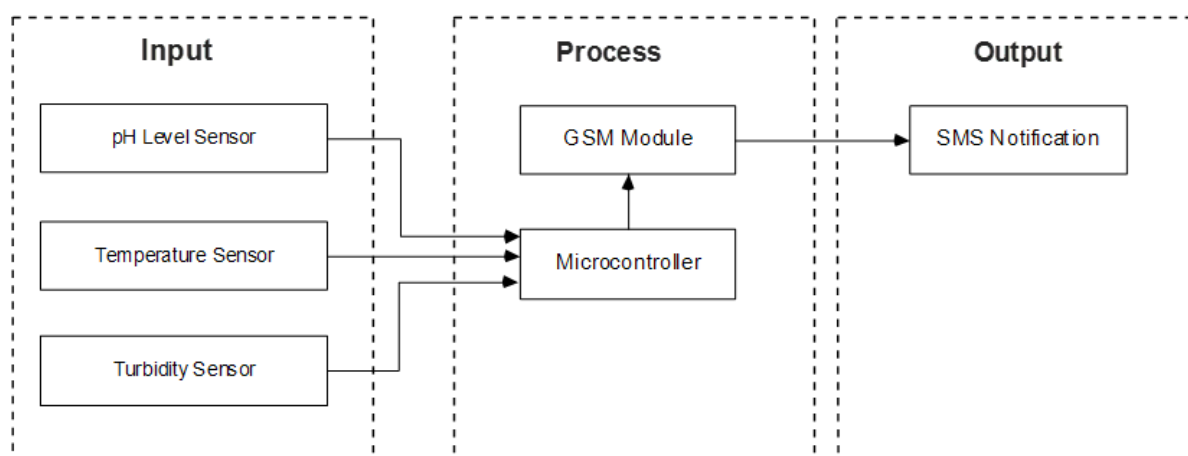


Figure 2. Theoretical framework of the micro-controlled swimming pool water quality monitoring system with SMS notification.

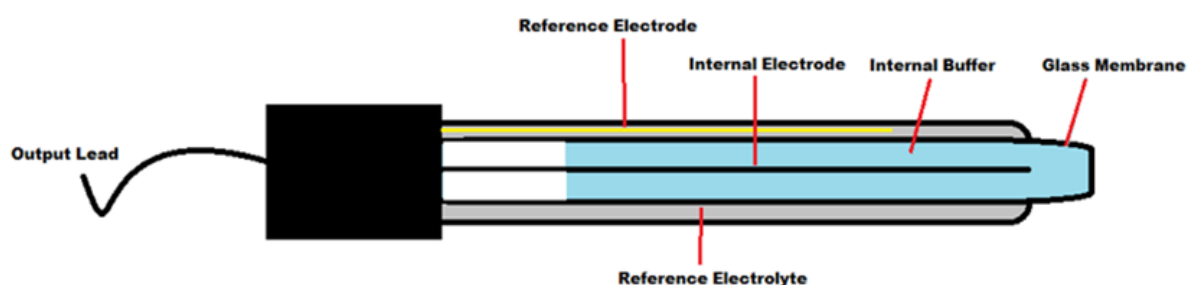


Figure 3. Structure of a pH sensor.

On the one hand, turbidity refers to the darkness or cloudiness of water caused by a large number of microparticles present in water that are invisible to the human eye, similar to smoke in the air. On the other hand, turbidity refers to the presence of microparticles in water that are invisible to the human eye. It is the method of measuring turbidity that is used to determine the quality of water in swimming pools. The turbidity of the water in the swimming pool is measured with the help of a turbidity sensor. Generally speaking, when the turbidity is low, the water is clear. The total amount of suspended solids in water is referred to as muddiness. Increasing the amount of turbidity in the water is a natural consequence of this increase. It is preferable to use a turbidity sensor to monitor the turbidity level of water in a swimming pool because the sensor uses light to detect suspended particles in water by balancing the light transmittance (Hasanah *et al.*, 2020), which is more accurate than other methods. The operation of a turbidity sensor is illustrated in **Figure 4**.

Figure 4 depicts the operation of a turbidity sensor in visual form. According to this sensor's operating principle, when light is passed through a sample of water, the amount of light transmitted through the sample is proportional to the amount of soil in the water of the

swimming pool. As the depth of the soil increases, the amount of light that can be transmitted decreases. When the turbidity sensor is used to determine the turbidity of the wash water, it measures the amount of transmitted light (Hasanah et al., 2020).

The Process is the second section of the framework. There are two components to the process: the microcontroller and the GSM module. The pH level, temperature, and turbidity are all connected to the microcontroller. The ATmega2560 microcontroller is used in the development of the board. The Arduino Mega is powered either by a USB connection or by an external power supply. The temperature, pH, and turbidity sensors are all connected to the Arduino board via wires or cables. To send an alert on the schedule of water draining in the swimming pool, the GSM module connected to the Arduino sends this information to the manager's or owner's mobile phone via an SMS message.

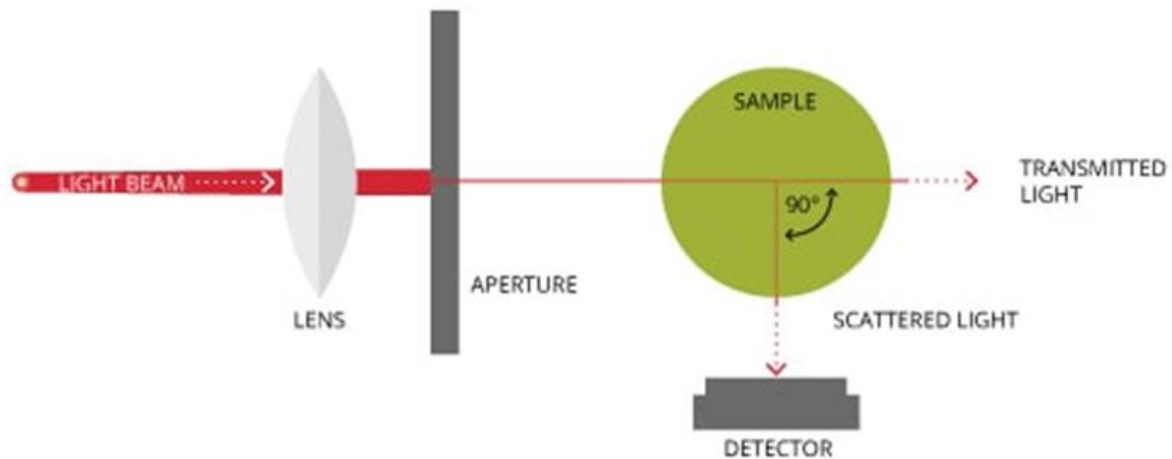


Figure 4. How turbidity sensor works.

At the end of the framework, the Output section contains an SMS notification system. Through an SMS notification, the Arduino sends the results to a server that is connected to the GSM module, which then sends the water parameter information as a report to the manager or owner of the facility.

3.3. Design of equipment

It was in this section that the methodology for the Micro-Controlled Swimming Pool Water Quality Monitoring System with SMS Notification was presented and described in detail. We also discussed in this chapter how the developed system's process is organized through the use of a structured approached modeling tool, as well as data flow diagrams such as the Context Diagram and the Level 0 Diagram, which are used to further discuss how the developed system operates and how it is structured.

The operational diagram of the developed system is depicted in **Figure 5**. As illustrated, the developed system is capable of operating with a variety of sensors, including turbidity, pH, and temperature. In general, the data from these sensors is accessed and controlled by the microcontroller to analyze the physical properties of the water in swimming pools. At the same time, it stored programs that were composed of a variety of conditions and lines of code that were executed after the program was completed. Various parameters of water quality monitoring, including pH level, turbidity, and temperature, are measured by sensors that send the data to the Arduino mega board for processing and display. The water quality sensors collect data and send it to the microcontroller, which then processes it. Data is analyzed by the microcontroller, and the output is stored in the database as a result of the analysis.

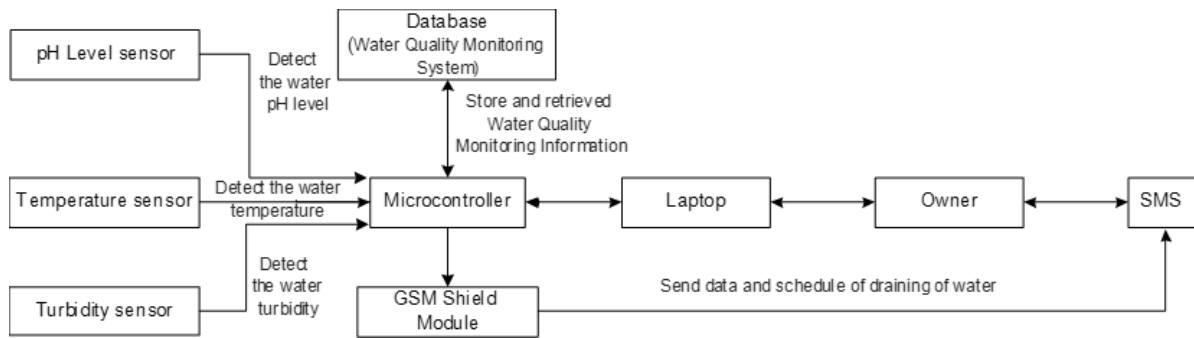


Figure 5. Operational diagram of the micro-controlled swimming pool water quality monitoring system with SMS notification.

Additionally, the owner makes use of a laptop computer to access data about the physical properties of water. GSM shield module transmits sensor readings from the collected data to the water quality monitoring user's mobile phone in the form of an SMS message. To report to the user when the water quality has reached a certain threshold level, Arduino will communicate with the GSM module, which will then send the user the water parameter and schedule of water quality when the water has reached a particular threshold level of water quality. All types of users will be able to use the developed system because it has been designed to be used for temperature detection, turbidity detection, and PH level detection.

3.4. Analysis and Design

A diagram showing the schematic diagram of the Micro-controlled Swimming Pool Water Quality Monitoring System with SMS Notification in which all of the physical components are shown is presented in **Figure 6**.

Each sensor that is connected to the microcontroller is uniquely pinned in the figure; there are a total of three sensors connected to the microcontroller. On the pH level sensor, the ground pin is wired to the microcontroller's ground, and the Voltage Common Collector (VCC) pin is wired to the microcontroller's 5-volt power supply. The pH level sensor's data pin is wired to the microcontroller's analog input pin 2, and the data pin of the pH level sensor is wired to the microcontroller's analog input pin 3. The turbidity sensor VCC pin is connected to the microcontroller's 5v power supply, the ground pin is connected to the microcontroller's ground, and the turbidity sensor data pin is connected to the digital input 9. The turbidity sensor data pin is connected to the digital input 9. The temperature sensor data pin is connected to the digital input pin 3 of the microcontroller, and the VCC pin is connected to the microcontroller's 5V power supply, while the ground pin is connected to the microcontroller's ground. The VCC pin of the GSM module is connected to the 5V power supply pin of the microcontroller, the txd pin is connected to the digital input pin 7 of the microcontroller, the rxd pin is connected to the digital input pin 2 of the microcontroller, and the ground pin of the GSM module is connected to the ground of the microcontroller.

Aside from that, the developed system's ability or capability to generate a systems report is achieved by reading the system logs from a Micro SD card using a Visual Studio Application, as depicted in the following data flow diagrams in **Figure 7**.

The context diagram of the Micro-controlled Swimming Pool Water Quality Monitoring System with SMS Notification is displayed in **Figure 7**. As shown in the diagram, the developed system consists of two (2) entities: The Micro SD card and the Owner. There is only one outgoing data flow from the Micro SD entity to the developed system which is System Logs which contains a summary record of water parameters content such as pH level, temperature,

and turbidity that was performed by the developed system. The Owner entity has only one incoming dataflow, which is System Report, which consists of reports on the summary of water quality information such as pH level, temperature, and turbidity in the form of SMS, where the information is sent and users are alerted about when the pool's water is to be drained. The Owner entity has no other outgoing data flows.

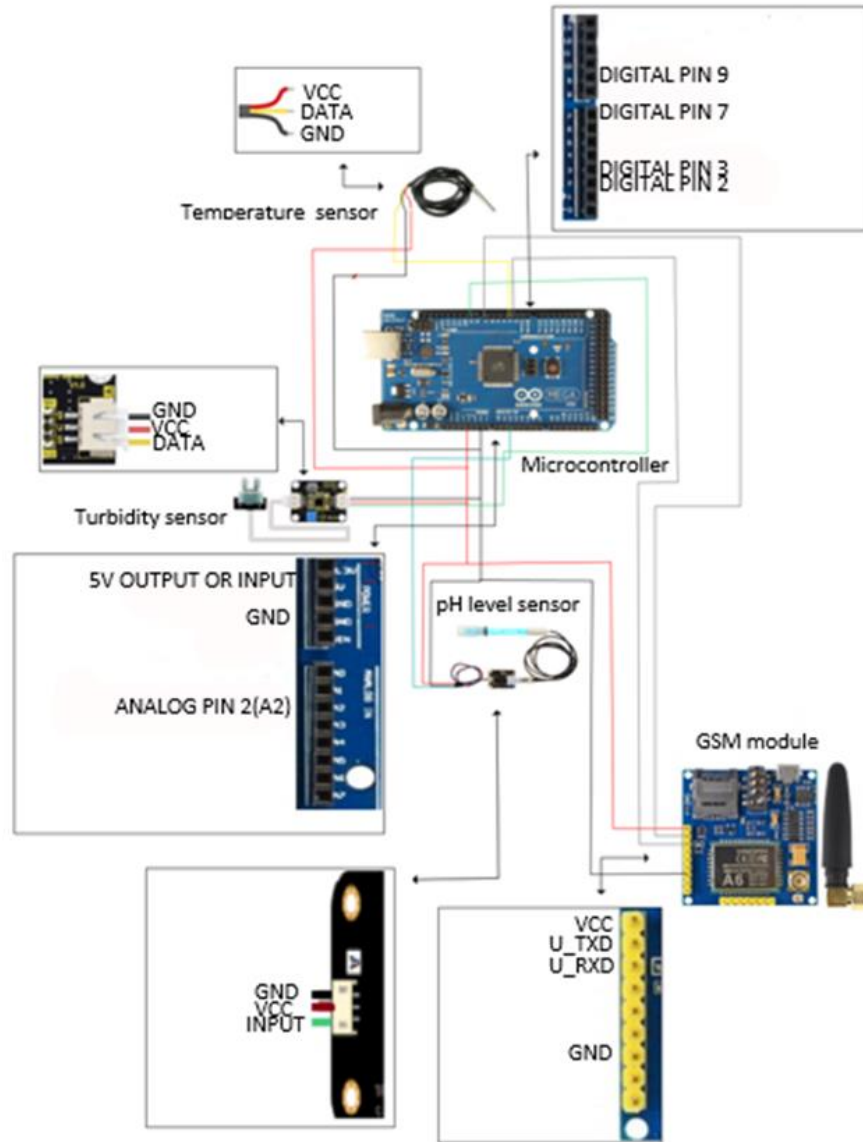


Figure 6. Schematic diagram of micro-controlled swimming pool water quality monitoring system with SMS notification.

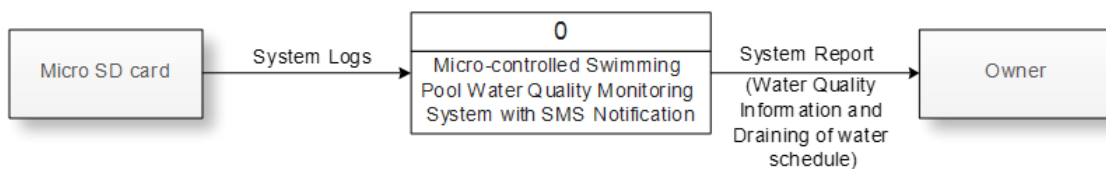


Figure 7. Context Diagram of the Micro-Controlled Swimming Pool Water Quality Monitoring System with SMS Notification.

The pH level, temperature, and turbidity of the water in a swimming pool are monitored by the developed system, which includes an Analog pH Sensor (E-201 pH), a Temperature Sensor (ds18b20), and a Turbidity Sensor, which are all used to detect the water quality of the swimming pool. The sensor collects data on the water quality of the swimming pool and stores it in a database for future reference. The sensor readings that have been collected are stored in the database of the developed system. After storing the water quality data, the developed system sends the information and schedule for draining the water from the pool to the appropriate personnel via SMS text message notification. Data flows for both entities are depicted and discussed in detail in **Figure 8**, which shows incoming and outgoing data flows for both entities.

Figure 8 depicts the data flow diagram for the Micro-controlled Swimming Pool Water Quality Monitoring System with SMS Notification at the level 0 data flow level. As shown in the diagram, during the initial process of the developed system, the Micro SD card sends system logs to the developed system, which receives and stores the system logs in which the water parameter content is recorded, and saves it in Database **Table 1** (DT1), which is the System Logs Information Table. Furthermore, the developed system generates System Reports, which contain information about the water quality and the schedule for draining the water, and sends these reports to the appropriate owner via SMS notification. The System Reports are made up of the readings from the water quality sensors, the schedules for draining the water, and the transactions that have been performed in the microcontroller, all of which are consolidated from the DT1.

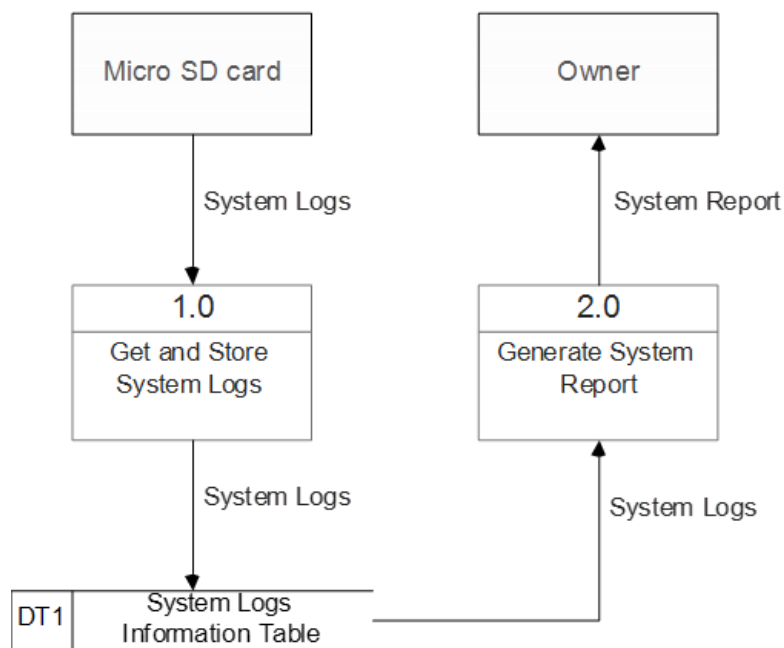


Figure 8. Level 0 data flow diagram of the micro-controlled swimming pool water quality monitoring system with SMS notification.

3.5. Data Dictionary

It is a collection of names, definitions, and attributes about data elements that are being used or captured in a database, information system, or as part of a research project that is known as a Data Dictionary. The following elements, as shown in **Table 2**, were incorporated into the developed system.

Table 2. System logs information table.

Attribute Name	Description	Data type	Default Value	Null Allows (Y/N)	Length	Validation Rule
SystemID	System ID number	smallint	None	N	25	None
temp_read	Temperature Readings	varchar	None	Y	25	None
pHlev_read	pH Level Reading	varchar	None	Y	25	None
turb_read	Turbidity Readings	varchar	None	Y	25	None
temp_des	Temperature Description	varchar	None	Y	25	None
pHlev_des	pH Level Description	varchar	None	Y	25	None
turb_des	Turbidity Description	varchar	None	Y	25	None
date	Date	varchar	None	Y	25	None
time	Time	varchar	None	Y	25	None

3.6. Development Approach

It is covered in detail in this section how to plan and analyze a swimming pool water quality monitoring system, as well as how to design, implement, and maintain a swimming pool water quality monitoring system with SMS notification. The development includes the following:

- (i) **Planning.** The planning phase is the first stage of the development of a system. During this phase, the researchers generally conceptualized and planned a scheme of action for creating all operational and related diagrams, which was then implemented. The assimilation of hardware, software materials, and equipment that will be used are included in this phase. Research and in-depth discussion on how to improve the manual monitoring of swimming pool water quality are being conducted right now.
- (ii) **Analysis.** This phase includes the analysis and construction of operational and related diagrams, which are based on the system requirements that have been developed during the planning phase of the project. During this phase, the researcher creates a block diagram of the system that has been developed. The identification of materials and other requirements has been completed during this phase. This was followed by the creation of every diagram that would be required for the implementation of the proposed system by our team. To develop the Micro-controlled Swimming Pool Water Quality Monitoring System with SMS Notification, the researchers conducted a thorough analysis of the development process.
- (iii) **Design.** The Design phase is the third phase of the process. During this phase, elements or factors such as the beneficiaries or respondents of the developed system, goals or objectives, and the cost of materials and equipment were all taken into consideration. In addition, the testing process is included in this phase to allow for the evaluation of the progress of the system being developed. Finally, in this phase, the application of the operational and other related diagrams that have been planned in the previous phases is completed.

- (iv) Implementation. It is during this phase that the newly developed system is put into operation to evaluate its functionality in terms of its capability and effectiveness. The researchers make certain that the developed system is ready to be used by the respondents or beneficiaries and that it has been tested for improvements before releasing it.
- (v) Maintenance. The fifth phase is concerned with maintaining the developed system in terms of its accuracy and responsiveness to user input. During this phase, the developed system is subjected to regular testing to ensure that it performs as expected when put into use.
- (vi) System Evaluation. An evaluation of the effectiveness of the newly developed system was carried out through a survey. All of the responses or ratings provided by the respondents on the survey questionnaire were collected and analyzed using a statistical tool to determine whether or not the developed system was accurate and useful to them.

3.7. Research Instrument

To gather information, the researchers used a survey questionnaire with a five-point Likert scale to assess the effectiveness of the developed system in terms of accuracy and usefulness, as shown in **Table 3**.

Table 3. Five-point likert scale model.

Scale	Verbal Interpretation	Definition
5	To a very great extent	Indicates that the developed system is extremely accurate, useful, or effective
4	To a great extent	Indicates that the developed system is very accurate, useful, or effective
3	To some extent	Indicates that the developed system is somewhat accurate, useful, or effective
2	To a slight extent	Indicates that the developed system is slightly accurate, useful, or effective
1	To a very slight extent	Indicates that the developed system is not accurate, useful, or effective

3.8. Budgetary Outlay

This section contains information about the budget and costs of the equipment that the researchers incurred to develop the Micro-controlled Swimming Pool Water Quality Monitoring System with the SMS Notification system. It displays the budgetary outlay, which includes a list of all of the items as well as the total cost required to complete the project's objectives.

Detailed budgetary expenditures for the Micro-Controlled Swimming Pool Water Quality Monitoring System with SMS Notification are shown in **Table 4**. As illustrated, the materials purchased to construct the developed system are subjected to an audit. All of the software that was used was free and open source. The laptop, which costs a total of ₱ 30,000.00, is the most expensive of the hardware-related materials. The developed system is valued at a total of one hundred twenty-two thousand one hundred twenty-five pesos (₱ 118,425.00) in the overall budget.

Table 4. Budgetary Outlay Micro-Controlled Swimming Pool Water Quality Monitoring System with SMS Notification.

Particular	Quantity	Unit Cost (₱)	Total Cost (₱)
Software			
Arduino IDE	1 software	Free	0.00
Microsoft SQL Server	1 software	Free	0.00
Hardware			
Laptop	1piece	30,000.00	30,000.00
Arduino Mega 2560	1 piece	2,400.00	2,400.00
Analog pH Sensor (E-201 pH)	1 piece	3, 200.00	3,200.00
Temperature Sensor DS18B20	1 piece	200.00	200.00
Turbidity Sensor	1 piece	625.00	625.00
GSM Shield Sim900	1 piece	1,600.00	1,600.00
Sub Total:			₱ 38,025 .00
Man Power			
Labor Cost	1	80,400.00	
Sub Total:			₱ 80,400.00
Grand Total			₱ 118,425.00

Furthermore, a work breakdown structure diagram, such as the one shown in **Figure 9**, displays the rendered time of the personnel's work throughout the system's development.

Figure 9 shows the Work Breakdown Structure of the Micro-controlled Swimming Pool Water Quality Monitoring System with SMS Notification. As illustrated, the planning phase took a total of 17 hours to conceptualize and plan a general plan of action for the development of the system. When it came to the analysis phase, it took 13 hours to thoroughly test the materials that would be used and determine how the developed system would function as a result. Another 10 hours were spent by the developer analyzing and preparing the algorithms for use in the creation of programming codes. During the design phase, the developer and system analyst worked together for 375 hours to develop the program and the system's Graphical User Interface (GUI), and the welder worked for 48 hours to construct the machine that would house the developed system. The developer and system analyst worked together for 12 hours to debug and test the developed system during the implementation phase. Furthermore, the system was checked and updated during the maintenance phase, which took 2 hours. Finally, it took 14 hours to complete the system evaluation phase. The system analyst spent 8 hours analyzing the problem that was encountered during the evaluation, and the software quality assurance team spent 6 hours testing, criticizing, and finding bugs in the developed system, which they then reported to the developer for improvement.

The Labor Cost Breakdown on the Work Breakdown Structure of the Micro-Controlled Swimming Pool Water Quality Monitoring System with SMS Notification is shown in **Table 5**. In the example above, the total labor cost of each individual throughout the entire development of the system is audited. The developer is the one with the highest cost in terms of personnel, with a total cost of ₱ 66,150.00. The labor costs associated with the developed system total eighty-thousand four hundred pesos (₱ 80,400.00) in total.

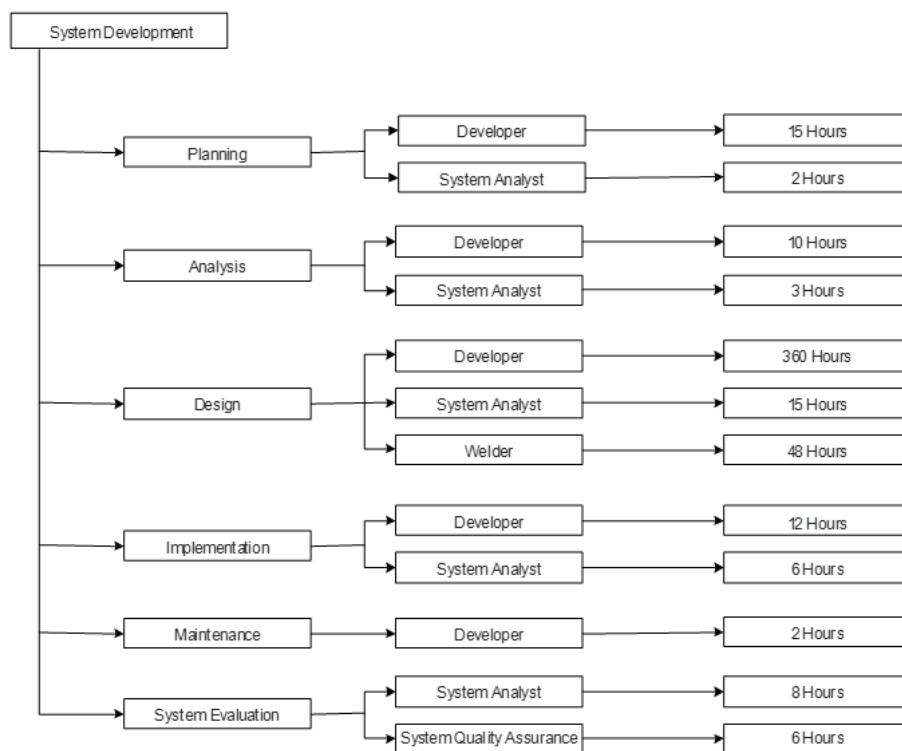


Figure 9. Work breakdown structure of the micro-controlled swimming pool water quality monitoring system with SMS notification.

Table 5. Breakdown of labor cost on the work breakdown structure.

Personnel	Labor Cost		
	Rate per hour (₱)	Total hours rendered	Total rate (₱)
Developer	250.00	315	66,150.00
System Analyst	225.00	30	6,750
Welder	250.00	24	6,000
Software Quality Assurance	150.00	10	1,500.00
Total:			₱ 80,400.00

3.9. Scope and limitation

The Micro-Controlled Swimming Pool Water Quality Monitoring System with SMS Notification was developed for use in both public and private swimming pools specifically designed for use in Tacurong City and Lebak, Sultan Kudarat. A variety of sensors, including pH sensor, turbidity sensor, and temperature sensor, were used in the development of the system, which was designed to monitor the physical properties of water in swimming pools, where the water source could be either flowing or groundwater. The data collected by these sensors in terms of water's physical properties were accessed and controlled by the microcontroller. A text message notification system was also included to provide information on the scheduled draining of water from the swimming pool. Aside from sensors and a microcontroller, the developed system also included a GSM module, which was used to communicate with other components.

Furthermore, the developed system generated summary reports on the water's physical quality parameters such as temperature, turbidity, and pH level, as well as water draining

schedules, using the data collected. The developed system could be used in the domestic water monitoring system to monitor the physical quality parameters of water such as temperature, pH level, and turbidity. The system could continuously log the temperature, pH level, and turbidity of water and issue alerts if any of the parameters are outside the acceptable limits for swimmable water.

4. CONCLUSION

The findings of this study demonstrated that the Micro-controlled Swimming Pool Water Quality Monitoring System with SMS Notification achieved its goal of accurately monitoring the physical properties of pool water in terms of its pH level, temperature, and turbidity using different sensors to provide water monitoring quality control among the swimming pools in Tacurong City and Lebak, Sultan Kudarat. The results indicate that the developed system is extremely effective for accurately detecting or measuring the physical properties of pool water and for producing precise records of water properties such as pH level, temperature, and turbidity (mean = 5.00, SD = 0.000). Additionally, the developed system is highly efficient at reducing the amount of time staff spends manually monitoring the water quality of swimming pools and their draining schedules, ensuring that the pools' water is routinely monitored to ensure client safety.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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