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Monitoring Water Quality in The Well-Water Processing System to Make Drinkable Water Based on IoT

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ABSTRACT

Indonesia is also inseparable from problems related to clean water. The city of Pekanbaru is currently experiencing rapid growth. In some big cities, the difficulty of clean water suitable for consumption is commonly felt by some residents, for example in Tuah Karya district – Pekanbaru. Moreover, this area is prone to flooding so the quality is getting worse because it smells and is cloudy. To produce clean water suitable for drinking that can be consumed by all levels of society. Water quality monitoring is also easy to do with IoT-based water quality monitoring tools. The goal of developing this prototype is to improve the healthy standard of living of the community by meeting the clean water needs of the prototype to be built. Seen from the main indicators, TDS and PH = TMS (Not Eligible) were obtained and followed by several other indicators that were still TMS. The results of the sample test showed that the water did not belong to the category of clean water and was suitable for consumption. After the water source of the drilled well is filtered using a tool made (without a manganese filter), the main indicators of TDS and pH are qualified.

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1. Introduction

Water is a natural resource that can be renewed with chemical substances with the chemical formula H2O in abundance on this earth, but its quality has decreased due to human activities that have an impact on environmental pollution[1]. Indonesia is an archipelagic country and two-thirds of Indonesia's territory is in the form of waters. However, Indonesia is also not free from problems related to clean water. The city of Pekanbaru is currently experiencing rapid growth. In several big cities, the difficulty of clean water suitable for consumption has been commonly felt by some of the residents, such for example in the Tuah Karya – Pekanbaru sub-district, moreover, this area is prone to flooding so the quality is getting worse because it smells and is cloudy.

Quality requirements include physical, chemical, radioactivity, and microbiological parameters that meet health requirements according to the regulation of the Minister of Health of the Republic of Indonesia No. 416/Menkes/Per/IX/1990 concerning water quality requirements and supervision [2]. Water that meets physical parameters is water that is odourless, tasteless, colourless, not cloudy or clear, and with a temperature preferably below air temperature in such a way that it causes a sense of comfort and a low amount of dissolved solids (TDS) [3]. Meanwhile, if reviewed based on chemical parameters, the water should not contain toxic chemicals, or metal content that exceeds clean quality standards [4]. In article 2 [5], Water in water sources according to their use/designation is classified into:

1. Group A, which is water that can be used as drinking water directly without treatment first.
2. Group B, namely water that can be used as raw water to be treated as drinking water and household needs.
3. Group C, namely water that can be used for fisheries and livestock purposes.
4. Group D, namely water that can be used for agricultural purposes, and can used for urban, industrial, and state electricity businesses.

In the development of this prototype, the water class that will be produced is Group B, which is water that can be used as raw water to be treated as drinking water and household needs [6]. The importance of this innovation is further developed Considering that water is a basic human need, this innovation is very important to be developed. This water quality monitoring tool is urgently needed by all levels of society [7]. Here are some of the advantages of using this tool: 1) Users will find it easier to detect clean water for daily needs without feeling worried. 2) users can clean the water filter regularly because if the water reservoir or commonly called the water tank is dirty, they will be warned through the user's smartphone, and 3) the quality of the clean water obtained has met the clean water quality requirements recommended by the Ministry of Health[8].

1.2 Previous Research

The previous research that produced the forerunner of the prototype to be developed was research entitled "Monitoring System for Water PH, Water Flow and Temperature in Internet of Things (IoT)-Based Shrimp Ponds". In the previous study, it was discussed related to water pH monitoring, flow monitoring, and temperature monitoring, this monitoring is very important because it affects the growth and success of shrimp farming [9]. In this case, the pH of the water must be maintained from 7.5 to 8.5. The temperature also affects the quality of the water so the optimal water temperature for shrimp cultivation is 28° – 30°C. and the speed of water currents that must be maintained is 3.1 m/s to 3.6 m/s. This research was published in a reputable international journal Q3 and can be seen at the link https://s.id/1NU16. The Internet of Things (IoT) is a concept where various sources of information can be exchanged, interacting with objects around us through an internet connection that can be controlled remotely. From the tools that have been produced, the idea of developing a prototype to process borewell water into clean water suitable for consumption has emerged considering that in Tuah Karya-Pekanbaru District, people still use gallons of water for cooking and drinking and this area is also still prone to flooding so that it affects water quality[10][11].

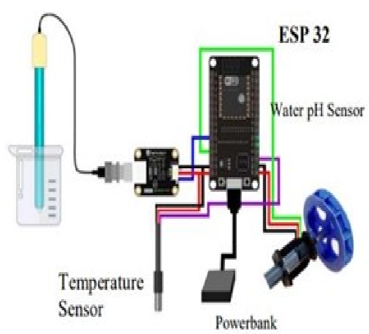
1.3 Research objectives

The purpose of developing this prototype is to produce clean water suitable for drinking that can be consumed by all levels of society. Water quality monitoring is also easy to do with IoT-based water quality monitoring tools [12]. The goal of developing this prototype is to improve the healthy standard of living of the community by meeting the clean water needs of the prototype to be built [13][14]

2. Research Method

2.1 Current prototypes

The prototype that has been produced so far is the Internet of Things (IoT)-based monitoring system for water ph [15], water flow, and temperature in shrimp ponds.



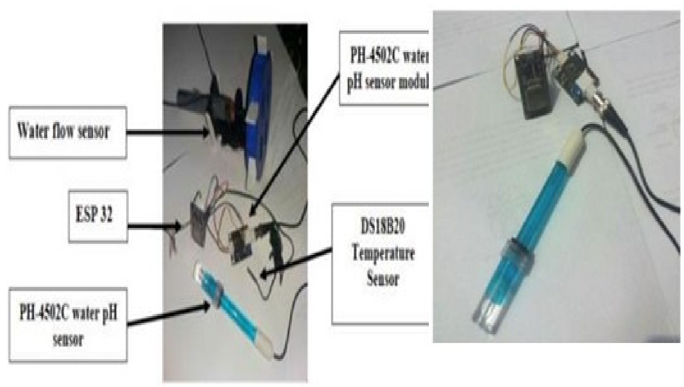


Figure 1. Current Prototype Products

2.2 Proposed Prototype with IoT

The research method on the prototype design of water quality monitoring equipment in the water treatment system of drilled wells into potable water based on IoT [16][17] is as follows:

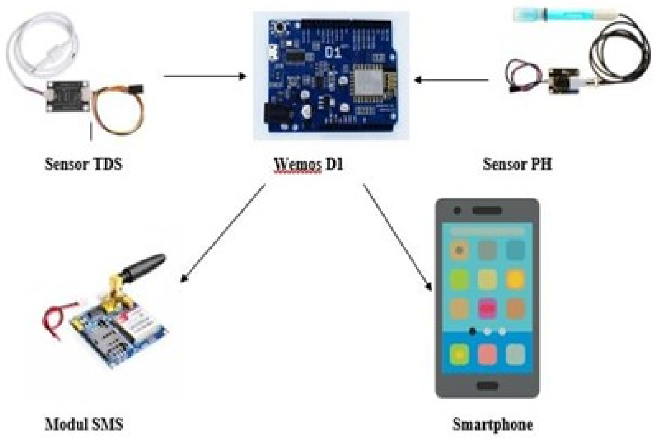


Figure 2. Internet of Things (IoT)-based Water Quality Monitoring Tool Components

The explanation from the picture above is:

1. The TDS sensor functions as an indicator to measure the amount of dissolved solids or particles in the water. A TDS meter is a tool that is often used to measure the amount of dissolved particles in drinking water. This TDS sensor will later provide information related to the amount of dissolved solids or particles in the water to Wemos D1.
2. The Ph sensor functions to determine the degree of acidity or alkalinity of a solution contained in water to Wemos D1.
3. Next, Wemos D1 will accommodate the data and inform Moudul SMS so that the data will be displayed on the LCD and then given through the user's smartphone so that it can be seen by the user[18].

3. RESULTS AND DISCUSSION

3.1 Prototype Physical Design

The following is the physical design of the Water Quality Monitoring Device in the BOR Well Water Treatment system into Drinkable Water based on the Internet of Things (IoT) [19]:

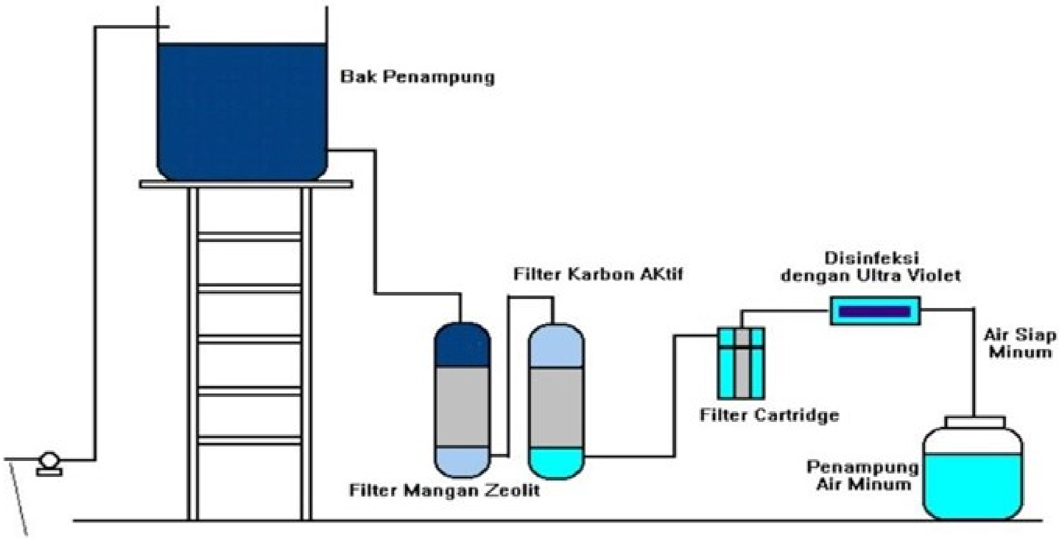


Figure 3. Physical Description of water quality monitoring equipment in the water treatment system of drilled wells into potable water based on IoT

In the picture above, the water that has been stored through the BOR well will go through 2 stages of filters, including a manganese zeolite filter and an activated carbon filter[20]. In this filter process, the water will be filtered and monitored by an IoT-based water quality monitoring device that has been made so that the TDS and Ph levels of the water produced can be monitored whether it is by clean water standards suitable for drinking by chemical indicators and through the regulation of the Minister of Health No. 416/MENKES/PER/IX/1990 concerning water quality requirements and supervision or not. If it is suitable, the water will enter the clean water reservoir ready to drink[21].

3.2 Design Results

As previously described, this tool has been implemented in residents' houses around the handsome sub-district and in the environment of gallon water entrepreneurs. The quality of the water produced through the filter of this monitoring device varies. This is because the quality of water in each region is also different. There are several filters that the implementation team added to overcome these problems. The filter in question can be seen in the image below:

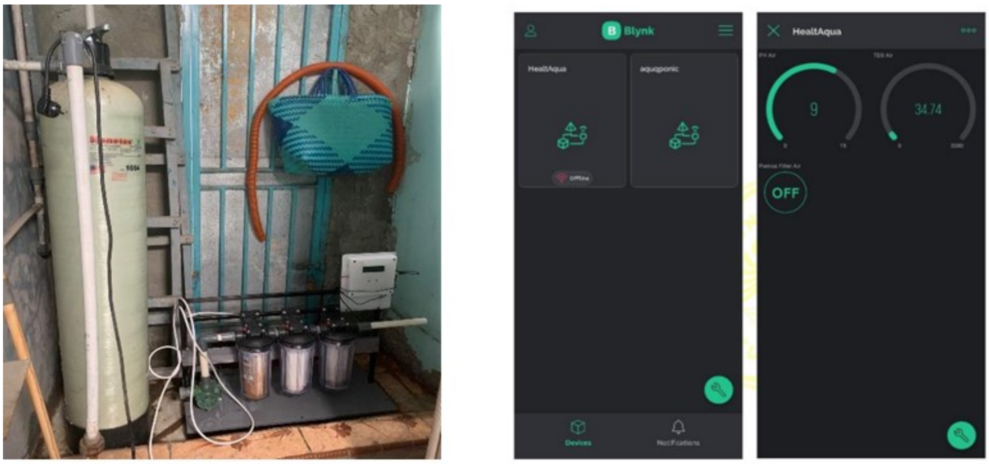


Figure 4. Addition of filters and water monitoring systems to Water Quality Monitoring devices

As previously described, this water filtration device has been implemented in several residential homes located around the Handsome Sub-district, as well as in the working environment of local gallon water entrepreneurs. These pilot implementations were intended to test the practical effectiveness of the device in real-world settings, under varying environmental and water source conditions.

The quality of water produced through the filter in these different locations showed considerable variation. This variation can be attributed to the fact that the raw water quality in each region is inherently different. Factors such as soil composition, groundwater depth, local industrial activity, and natural mineral presence greatly influence the levels of contaminants in the water. As a result, in some areas, the device was able to produce clean water that met almost all required standards, while in other areas, the same filtration system required additional support to address more severe contamination levels.

In response to these findings, the implementation team conducted further analysis and made several adjustments to the filter configuration. To enhance the device's adaptability across different water conditions, the team added specific types of filters tailored to local needs. For example, in regions where high concentrations of iron were detected, an iron-removal filter was included. In areas where bacterial contamination was more prominent, additional antimicrobial or activated carbon layers were added to improve biological filtration.

These adjustments reflect the flexible and modular nature of the device, which allows it to be modified according to the specific challenges of each deployment site. This adaptability not only improves the overall effectiveness of the device but also ensures that communities with different water profiles can still benefit from the same core technology. The implementation team continues to monitor performance across locations and gather user feedback to support ongoing refinement and potential scaling of the device for broader use.

The contents of the filter include:

1. Manganese Chemical Filter as a Removal of Iron in Water
2. Sediment filter (stage 1 filter) serves to filter large particles such as dirt, sludge, sand, & dust
3. Sediment filter (stage 2 filter) functions to filter large particles such as dirt, sludge, sand, dust
4. CTO (Chlorine taste odour - stage 3 filter) Has 2 functions 10-micron sediment and activated carbon that absorbs odours, colours, unpleasant tastes, organic chemicals, and chlorine in the advanced stage.

The water quality monitoring system can be viewed in real-time based on Android, and the test results of the measurement results obtained on the IoT-based water monitoring system can be concluded to be 98% accurate.

3.3 Testing

Testing Stage Carried Out:
1. Independent testing of the tool by the Implementation Team
2. Taking water samples at residents' homes to be tested at the Riau Health Office Labor
3. Phase 1 Testing in Residents' Homes
4. Phase 2 Testing in Residents' Homes
5. Testing in the Operational environment (test the results of the Depot water sample with the results of the water sample produced by the equipment.

The test results can be seen in the following table:

Table 1. Water Sample Test Results

No	Water Type	Before Using the Tool		After Using the Tool	
		Level pH	Level TDS	Level pH	Level TDS
1	Borewell Water Sample 1	5.0	611	7.3	0.10
2	Borewell Water Sample 2	5.3	520	8.0	0.40
3	Borewell Water Sample 3	5.0	611	7.8	0.19
4	Gallon Water Samples (Drinking Water Depots)	7.0	0.11	7.0	0.20

Table 2. Results of Comparative Testing of Water Results that have been filtered with Tools that Have Been Processed

No	Water Type	Before Using the Tool		After Using the Tool	
		Level pH	Level TDS	Level pH	Level TDS
1	Borewell Water Sample 1	8.3	0.13	7.3	0.10
2	Borewell Water Sample 2	7.8	0.30	8.0	0.40
3	Borewell Water Sample 3	7.8	0.23	7.8	0.19
4	Gallon Water Samples (Drinking Water Depots)	6.8	0.15	7.0	0.20

The testing phase of the water filtration device was conducted through several structured stages to ensure comprehensive evaluation of its performance. The first stage involved independent testing by the implementation team, which was carried out to assess the initial functionality and reliability of the device in a controlled environment. This internal testing provided a baseline for evaluating the tool before deployment in the field.

Following this, water samples were taken directly from residents' homes and submitted to the Riau Health Office Laboratory. This step was crucial for obtaining official and standardized test results, particularly for key indicators such as TDS, pH, iron content, and bacterial contamination. The third stage, known as Phase 1 field testing, was conducted in selected residential homes. This phase aimed to observe how the device performed in actual household conditions, allowing the team to monitor its usability and effectiveness based on the varying water qualities in different areas.

Phase 2 testing was then carried out, involving homes where further filter adjustments had been made. This phase helped validate improvements introduced after analyzing Phase 1 results, especially in areas where initial results showed the presence of excessive contaminants. Finally, the device was tested in an operational environment, specifically within the setting of gallon water depots. This final phase involved comparing water samples processed by the developed device with those produced by commercial depot systems. The goal was to measure how the device's output matched up to or differed from commercially purified water.

Altogether, these five stages of testing provided a thorough and multi-perspective evaluation of the filtration device, ensuring that it performs effectively both in laboratory settings and under real-life usage conditions. The results also served as the basis for continuous improvements to the device, with the ultimate goal of making it suitable for broader community use and potential mass production.

4. CONCLUSION

With sincere appreciation, I would like to express my deepest gratitude to all parties who have provided invaluable support, guidance, and encouragement throughout the process of this research. The successful completion of this study would not have been possible without the involvement of those who generously offered their time, knowledge, and motivation at every stage. I am especially thankful for the continuous assistance and constructive feedback that helped me refine my ideas, overcome challenges, and stay committed to my goals. Every suggestion and piece of advice has been instrumental in improving the quality of this work. I truly appreciate the contributions from academic mentors, technical staff, and fellow researchers whose input has played a significant role in shaping this research into its final form.

This research aimed to develop a water filtration device that could improve water quality and address issues related to access to clean water, especially in areas dependent on drilled wells. After the device was developed, independent testing was conducted to evaluate its performance. Following the independent trials, the device underwent further testing by the Health workforce to validate the results under official standards and procedures. During the initial testing of water samples—prior to filtration—the main indicators, namely Total Dissolved Solids (TDS) and pH, were classified as TMS (Not Qualified), along with several other parameters that also failed to meet the required thresholds. These findings indicated that the water source did not fall under the category of clean water and was unsuitable for direct human consumption.

After filtration using the developed device (without the inclusion of a manganese filter), the test results showed a significant improvement. The TDS and pH levels had improved to fall within acceptable limits, indicating that the filter was effective in addressing the most critical aspects of water quality. However, certain elements such as iron and bacteria remained at levels above the acceptable range. Despite this, there was a clear reduction in their concentrations, which demonstrates that the filtration system improved overall water quality even if it did not fully eliminate all contaminants in its basic form.

Overall, the activities carried out during this research progressed smoothly and according to the planned objectives. The improvements in the water's key indicators—particularly TDS and pH—suggest that the device is technically viable and ready for mass production. According to statements from the Health Labor involved in the testing, the water processed through this device is classified as clean water and is suitable for daily use such as washing, cleaning, and even consumption after boiling. However, due to the remaining presence of iron and bacterial content, the water is not yet deemed safe for direct drinking. Boiling the water before consumption is currently recommended.

To address these remaining issues and improve the device's effectiveness, the implementation team decided to incorporate an additional filter that contains manganese-based chemicals. This modification is intended to target and remove iron and bacterial contaminants more thoroughly, thereby increasing the safety and quality of the water for drinking purposes. With this enhancement, it is expected that the final version of the device will be able to produce water that meets all standards for clean and safe drinking water, making it a practical solution for communities with limited access to safe water sources.

Acknowledgments

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