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Analysis Of Early Warning System In Cold Room Vaccine Storage With Iot System

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ABSTRACT Cold room as a cold room for vaccine storage is an environment with a controlled temperature used to maintain and distribute vaccines in optimal conditions. The results of this review are expected to be a reference for researchers and readers with the development of research using the DS B1820 temperature sensor which will analyze the results of the data logger output and linearity at sensitive locations Cold Room with LCD output and equipped with an IoT system web display on a PC for monitoring and alarm and notification via telegram when there is a change in temperature approaching and outside the range of 2 - 8 ° C so that this can make it easier for officers to monitor the temperature and quality of the vaccine. In the results of the study, temperature graphs and temperature data can be displayed which are recorded in minutes. Temperature measurement with standard tools produces the largest difference of 0.83. The lowest temperature was 2.06°C and the highest temperature was 8.31°C as well as telegram notification of early warning (2.58°C), evacuation vaccine (2.31°C), and exposed vaccine (8.6°C). With this research a Warning System was obtained which was achieved with telegram notifications namely early warning, evacuation vaccines and exposed vaccines to maintain vaccine quality.

INDEX TERMS Cold Room, Early Warning, IoT, Temperature

I. INTRODUCTION

In the cold room as a cold room for storing vaccines, the temperature detected must be monitored properly, in several studies mention CCE (Vaccine Cold Chain Equipment) with poor handling in various countries [1][2][3] by effective vaccine management [4] with a temperature range used for vaccine storage of 2 – 8 ° C[5][6], therefore this vaccine storage requires a compatible system [7][8] by the World Health Organization (WHO) guidelines for monitoring this temperature also influenced by the location of the sensor in the room, sensors are placed in every corner of the room and doors [9]. One of the sensors to detect the temperature in a cold room that is often used is the DS18B20 sensor, the DS18B20 sensor with digital output, works by changing the temperature scale into a voltage quantity, and also found sensor error at 0.1 to 0.4 [10] with a temperature range of -55°C and +125°C [11]. Considering that monitoring the temperature in this room greatly affects the condition and quality of the vaccine over a long period [12], users often find problems, namely monitoring the temperature in the

cold room is less effective so that when there is a spike or unstable temperature the user cannot immediately evacuate.

In its development, various related research developments have been made with the addition of storage monitoring to maintain material quality because of the biggest contributing factor to damage [13]. In monitoring the temperature of the vaccine cold chain [14] with an LCD on the outer wall [15], in this case, there is a drawback because temperature monitoring can only be done on the LCD and cannot be done remotely, so there is a high risk when the temperature is unstable. Cloud service for low-cost temperature monitoring to realize Health risk management solutions involving cold chain management [16]. Furthermore, in the development of IoT or web of things [17] [18] in real-life applications from various domains, such as health, security, and marketing [19] and research has also been made with platform interfaces [20], but in this case, there are limitations. data recording is used for vaccine storage with a duration of 30 days for data evaluation. Further research has been carried out in 2020 with a control indicator system for alarms and SMS notifications [21][22].

This technology makes it easy for logistics staff to diagnose problems by displaying temperature details in real-time and notifications using SMS also carried out by Hasanat et al [23], and also developed with a web system, to monitor the performance of chain monitoring that can send temperature data then stored in a database that is stored in a database, accessible via a web browser [24][25]. The disadvantage of this method is that there is no early warning for unstable temperatures and notifications that cost money [22].

Some of these previous studies are expected to make it easier for researchers to develop the quality and accuracy of cold rooms with early warning analysis using the DS B1820 temperature sensor which will analyze the results of the data logger output and linearity at sensitive Cold Room locations with LCD output and equipped with an IoT web display system on a PC for temperature monitoring for 30 days as well as alarms and notifications via telegram when there is a change in temperature approaching and outside the range of 2 - 8 °C so that this can make it easier for officers to monitor the temperature and quality of the vaccine.

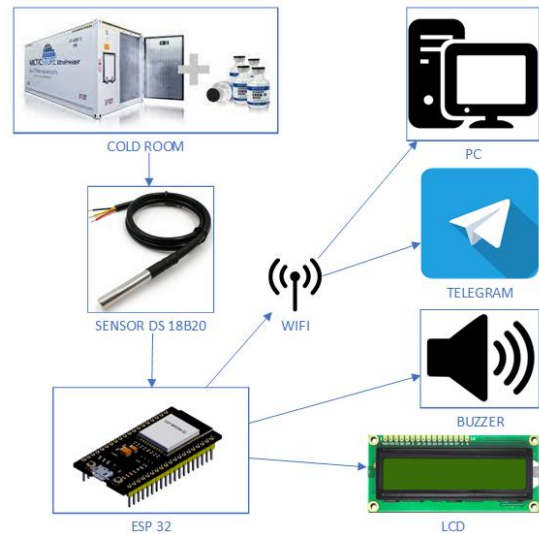


Figure 1 The diagram block of Early Warning System for Monitoring Coldroom Temperature

II. METHODOLOGY

Temperature monitoring requires a data processing system that is managed in a cloud service that has extensive data access [26][27]. Internet of things is a service to connect objects (things) both physical and virtual based on internet technology, one solution that can be used is the use of IoT which can be used as a means of data collection, using several protocols [28] IoT is often used for reading multiple sensors whose output is managed by software and displayed on several platforms or the web [29]. The web display is intended to record the output of the sensor in real-time [30]. Overall, the temperature monitoring process can be seen in Figure 1. Data processing with a esp32 tools to record a temperature of coldroom in a range (hours) and the result will be displayed to website and notification by telegram.

In the block diagram figure 2 below, the DS 18B20 sensor detects the cold room temperature in real-time and produces a temperature output that has been processed according to the specified range, which is 2°C - 8°C with the specified set point being 3.8°C. In this case, the output is processed on the microcontroller and the wifi module used is ESP 32 [31] [32]. and displayed via the LCD. The temperature output also displays a data logger on the web for temperature monitoring from the detected temperature sensor. The specified temperature range causes monitoring in 2 conditions, namely the temperature in the controlled range and outside the range. When the temperature moves away from the setting point continuously for a certain period, the early warning system will run until it reaches the temperature limit of 2°C or 8°C. In conditions of early warning and out of range, a notification will be sent via telegram and accompanied by an active alarm buzzer.

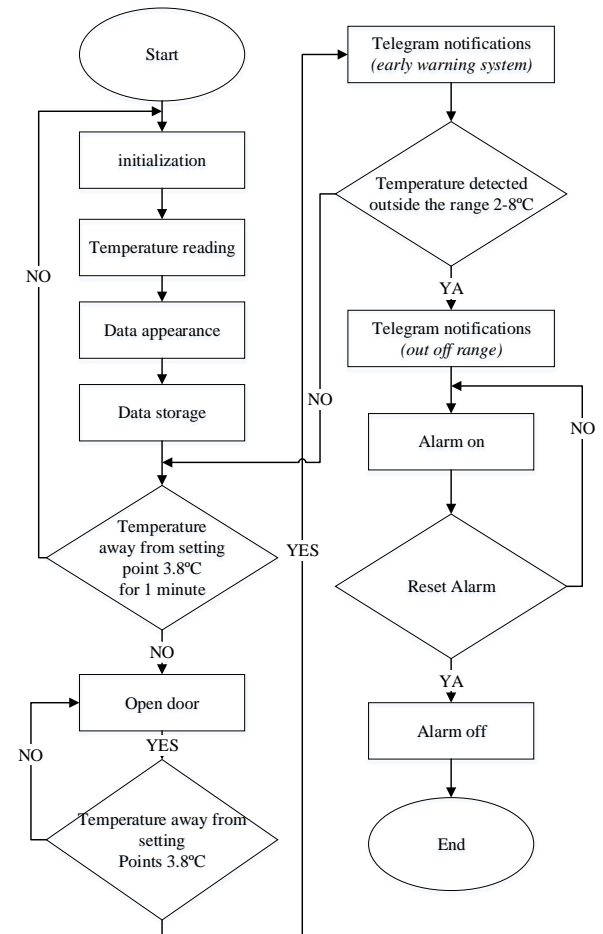


Figure 2 Flowchat of Temperature Monitoring in Coldroom with Early Warning Sistem by Telegram Notification

III. RESULT

In this study, the DS 18B20 temperature sensor detects the cold room temperature in real-time, and produces an output temperature that has been processed according to the specified range, which is 2°C - 8 °C. Table 1 below is the retrieval of temperature data in a matter of minutes or data updates every minute, the temperature values are obtained in the range and some exceed the lower and upper limits. The results of table 1. obtained temperature values with a range of 2°C – 8°C and some are out of range, above 8°C.

Table 1
DS 18B20 Temperature Sensor Data Output

Output Sensor Suhu DS18B20												
Temp	Data Collection every 1 minute											
	1	2	3	4	5	6	8	9	10	11	12	
Out of Range <2°C												
2°C – 8°C	√	√	√	√	√	√	√	√	√	√		
Out of Range >8°C											√	

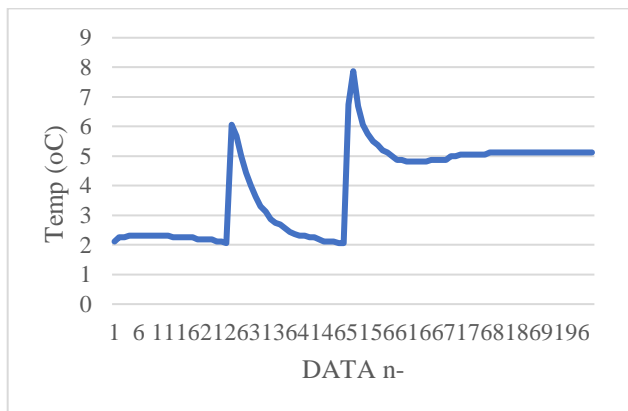


Figure 3 Graph of Cold Room Temperature Day 1 with a Duration Of 2 Hours (120 Minutes)

Figure 3. the graph of cold room temperature taken in a period of 2 hours or 120 minutes with the DS18B20 sensor obtained a temperature range of 2.06°C to 7.87°C.

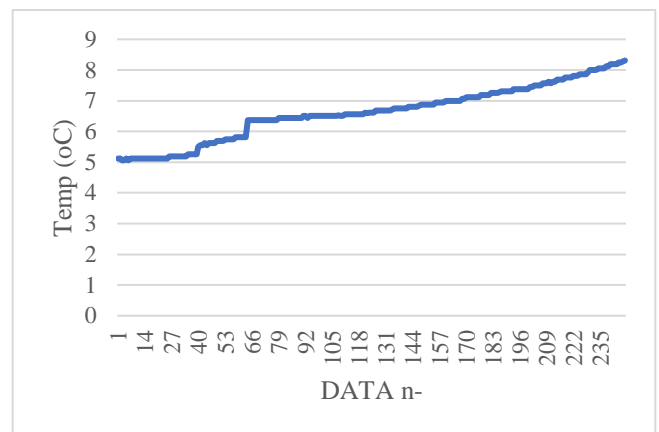


Figure 4 Graph of Cold Room Temperature Day 2 with a Duration of 8 Hours (480 Minutes)

Figure 4 above is a graph of the cold room temperature taken in a span of 8 hours or 480 minutes with the DS18B20 sensor, the temperature range is 5.06°C to 8.31°C. It is temperature range out of range

In Figure 5 and Table 2 are data obtained from the output of the DS 18B20 sensor detecting the temperature in the cold room in a state where the temperature setting is activated by using a running timer to compare the value with the standard log tag, there is a difference with the largest value of 0.83 °C. The following data as a reference for temperature detection in the cold room which will be used for the analysis of the warning system is appropriate.

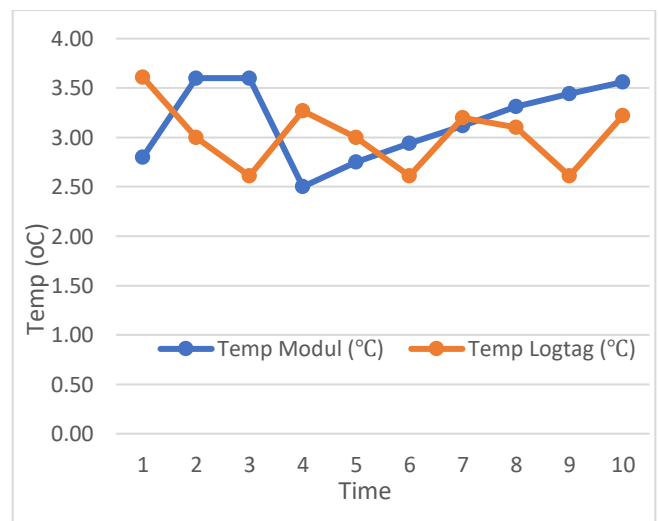


Figure 5 Comparison Graph of DS 18B20 Temperature Sensor Value with Comparison Tool

Table 2
Module Temperature Data Measurement with Logtag Temperature Data (Comparison)

No	Temperature of Module (°C)	Temperature of Log tag (°C)	Difference	Error
1	2.80	3.61	0.81	22%
2	3.60	3.00	0.60	20%
3	3.60	2.61	0.99	37.9%
4	2.50	3.27	0.77	23.5%
5	2.75	3.00	0.25	8.3%
6	2.94	2.61	0.33	12,6%
7	3.12	3.20	0.08	2.5%
8	3.31	3.10	0.21	6.8%
9	3.44	2.61	0.83	31.8%
10	3.56	3.22	0.34	10.6%

The results of temperature monitoring with the DS18B20 sensor will then be processed with a microcontroller program to be output in the form of displays, alarms, and notifications. The following is an example of an IoT web base display for monitoring cold room temperature data. In Figure 6. the web base login menu for monitoring the cold room temperature can be accessed by the user.



Figure 6 Image of Cover Page Web Base Cold Room Temperature Monitoring

There is a temperature display menu that is detected by the DS 18B20 sensor in real-time and is updated, the stored temperature can be downloaded in the form of excel data and printed. The selection of stored data can be selected using a range of days by entering the date in the column (next to Load) and then selecting the Load menu.

No	Time	Temp
11	2022-08-15 20:46:39	2.19°C
12	2022-08-15 20:47:09	2.81°C
13	2022-08-15 20:47:40	0.37°C
14	2022-08-15 20:48:10	-0.56°C
15	2022-08-15 20:48:41	-0.5°C
16	2022-08-15 20:49:12	1.31°C
17	2022-08-15 20:49:42	2.06°C
18	2022-08-15 20:50:12	2.56°C
19	2022-08-15 20:50:42	2.87°C
20	2022-08-15 20:51:12	3.06°C

Figure 7 Display of Stored Temperature Data on Website (Normal)

No	Time	Temp
1521	2022-09-28 12:40:53	2.9
1522	2022-09-28 12:41:23	3
1523	2022-09-28 12:41:53	3.1
1524	2022-09-28 12:42:23	3.3
1525	2022-09-28 12:42:53	3.4
1526	2022-09-28 12:43:23	3.5
1527	2022-09-28 12:43:53	14.5
1528	2022-09-28 12:44:23	13.7
1529	2022-09-28 12:44:53	9.4
1530	2022-09-28 12:45:23	7.1

Figure 8 Display of Stored Temperature Data on Website (Abnormal)

The stored data can also be displayed on the website with an overview of 20 data per page as shown in Figure 7. In Figure 8, there are color differences in temperature, namely during early warning at temperature limits of 2.62°C, 2.75°C, and 2.87°C, and brown when temperatures are detected at 2.06°C, 2.19°C, and 2.31°C.

IV. DISCUSSION

The temperature data that has been detected by the DS 18B20 sensor will then be analyzed by the Early warning system with telegram notifications and buzzers. A notification will appear with the condition that the temperature is beyond the minimum and maximum limits that are read by the DS 18B20 sensor. Temperature measurements taken every minute produce temperature monitoring with the biggest error of 35.9%. The temperature linearity that has been monitored is in the range of 2°C - 8°C, the lowest temperature is 2.2°C and the largest temperature is 5.7°C and with a simulation system a Warning System is obtained which is achieved with telegram notifications namely early warning, evacuation vaccines and exposed vaccines.

In the previous research in 2015, Ting Lu, et al made a tool on the Temperature Control System of Storage. This study uses a temperature sensor, it cannot be remotely, so there is a high risk when the temperature is unstable [8][9]. In 2017 Naveen Kumar, et al researched the Temperature Mapping Study in Cold Room. In this case the researchers mapped the temperature of 18 data loggers used which were placed in certain areas in the temperature range between 2 ° C to 8 ° C[10], the results obtained were unstable temperature monitoring including in a position near the door with a value of 12.56 ° C with the method of opening the door for 10 minutes because there is mobility of officers [10], [11][12]. In 2020 Bengiovani, et al created the IoT Technologies and Smart Monitoring System for a Good Cold Chain Management tool. This research is for temperature monitoring and also for system control. If an indication occurs, it will be marked with a sounding alarm, but there is no early warning in this system [18][13]. In Raisa Tahseen, et al's research in 2020 with the title An IoT based Real-time Data-Centric Monitoring. This technology offers logistics staff convenience in diagnosing problems by displaying temperature details in real time and notifications using SMS, however this system has constraints for officers because SMS notifications require costs [19][20]. Management of coldroom very important such as for hospitals, health centers, and pharmacies [33] so it must meet the applicable requirements for proper storage [34][35], temperature monitoring is very necessary for the formation of an accurate cold storage chain [36][37] and required a system that is adaptive to the environment or temperature that is in the room or outside [38] and some standard recommendations for appropriate vaccine services [39].

V. CONCLUSION

The purpose of this paper is to review papers related to research on temperature monitoring in cold rooms of vaccine storage rooms by using an early warning system to make it easier for officers to determine room conditions that are by standards. The sensor uses DS 18B20 sensor to detect the cold room temperature. Temperature measurements were taken every minute resulting in temperature monitoring with the largest difference of 0.83. The lowest temperature was 2.06°C and the highest temperature was 8.31°C the Warning System was achieved by telegram notification, namely early warning (2.58°C), evacuation vaccine (2.31°C), and exposed vaccine (8.6°C). Module development can be carried out in further research by monitoring temperature not only in storage but also in the vaccine distribution process. for further development, you can add the development of a temperature monitoring website, not only for storage, but also for the process of distributing vaccines and notifications used, which can be developed in a more efficient way.

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