

## RESEARCH ARTICLE

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# Lost Data and Transmitting Speed Analysis on Incubator Analyzer Based IoT Technology

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**ABSTRACT** The importance of the readiness of the baby incubator for critical infant patients who are treated intensively encourages health technicians to carry out regular maintenance and calibration to overcome the problem of equipment malfunctions. Critical infant patients are babies who are treated in the NICU (Neonatal Intensive Care Unit) due to premature birth or babies using incubators are diagnosed with abnormalities or diseases, this situation makes babies need tools for survival, especially in the first month. Calibrating temperature control is very necessary for the incubator. In addition to temperature, it is necessary to control humidity so that the baby's respiratory system is in optimal condition. In addition, it is also equipped with a noise sensor to ensure that the noise in the baby incubator room is appropriate. From the above problems, a tool for temperature testing was made using a DHT22 sensor with five measurement points, humidity with a level of 30% RH - 60% RH and noise with a range of 30dB-60db to ensure the tool functions properly equipped with a lost data testing system and delivery speed. using internet access with thingspeak display. This research resulted in the design of a calibration tool with three parameters, namely the temperature setting at 33°C the smallest error percentage is 0% and the largest error is 0.96%, and at the temperature setting 35°C the smallest error percentage is 0.28% and the largest error is 4.1%, humidity with an error percentage of 0.82% and noise with an error percentage of 0.93%. The drawback in using the Thingspeak application is that there is a limit on the channel ID, which can only display 8 readings, while the minimum time lag is 20 seconds. For the MAX4466 noise sensor, there are shortcomings, namely the accuracy in readings is not good.

**INDEX TERMS** Internet of Things (IoT), Lost Data, Delivery Speed, Three Parameters.

## I. INTRODUCTION

Baby incubators that directly affect baby's health make important contributions to the implementation of accurate diagnosis and treatment for the patients [1]. However, the correct diagnosis and treatment are directly related to the reliability of the devices. When the impact of the incubator on baby health is considered, the ambient conditions such as sound level, light level, air ventilation and the quality of the electricity grid come into prominence. Basically, the premature new born baby's nervous system is in a status of general immaturity[2]. Measuring instruments or instruments, must contain the ability of precision and accuracy in any case. Accuracy is the price closest to an instrument reading close to the actual price of the measured variable. Accuracy is a

measure of the ability to obtain similar measurement results. Each measuring instrument can be considered good if it has been proven by a test tool, called tool calibration [3]. According to Decree No. 54 of 2015 on Calibration, calibration is an application activity to determine the correctness of the value of measuring instrument designation and measuring material data [4][5]. According to the Organization of International Standards ISO/IEC Guide 17025 calibration is an activity to determine the conventional correctness of the value of measuring instruments and measuring materials by comparing against measuring standards that are able to search to national standards for units of measure and / or international. The management system be it the ISO quality management system, the environmental

management system, or the Occupational Health and Safety Assessment Series (OHSAS) occupational health and safety management system also requires in one of the provisions that the equipment used in a company that affects quality, environment, or health must be calibrated or verified periodically[6][7][8]. Medical equipment is in dire need of maintenance and supervision to avoid malfunctioning medical devices. Maintenance function is an effort or process of activities to maintain technical conditions. The maintenance activities of health equipment consist of planned maintenance which includes preventive maintenance as well as corrective maintenance, and unplanned maintenance. In addition, testing or calibration is also needed in maintenance activities. Calibration is the overall action including physical examination and measurement to determine the characteristics of medical devices, so that it can be ascertained the suitability of medical devices to work safety. This activity aims to ensure medical equipment can function properly when needed and increase the efficiency and effectiveness of medical equipment for optimal health services [9].

One of the medical devices that need to be calibrated periodically is the baby incubator, due to frequent constraints on temperature, humidity and noise that can be risky to the baby being treated. As for checking the temperature, humidity and noise, this is using an incubator analyzer. Incubator analyzer is a device designed and built to verify the operation and environmental conditions of baby incubators that can record parameters such as noise, temperature, and relative humidity[10][11]. Newborns need special attention to the delivery process, this affects the health of the baby itself. The temperature around the baby is conditioned according to the needs of the baby so that the baby is able to adapt and not susceptible to disease, related to the need for incubator tools that help normalize the temperature and humidity around the baby's body. According to who, premature babies are babies born alive before the gestational age of the 37th week (calculated from the first day of the last period). The American Academy of Pediatrics, took the 38-week limit to call premature. A premature baby is a baby born under 37 weeks or weighs less than 2,500 grams.[12][13].Therefore, the importance of calibration in baby incubators to avoid unwanted risks such as burns and even death in infants. Premature babies generally need to be placed in incubators with controlled room temperature, so that the baby remains at the appropriate temperature while the baby is in the womb. Incubator Analyzer tool has previously been made with the addition of air flow sensor parameters, batteries and 4x20 character LCD display by Ahmad Syaifudin and Denny Prasetyo in 2015. But on the water flow sensor can not reach a range of 0.7 m / s (which reads range 0 - 1.2 m / s). In addition, the noise sensor cannot detect in the range of 30 dB – 60 dB (which reads only in the range of 42-55dB for measurements outside the baby incubator, while inside the baby incubator in the range of 52-58 dB), on the humidity sensor at the range of 50% - 90% (which reads at the range of

88.61%) and the per-parameter measurement process must be alternately because it uses only one display. These conditions cause the value to read less linearly. Then it was redeveloped with the addition of data delivery via Bluetooth displayed via Personal Computer by Vina Alfi Majidah and Ericka Helen Reynilda (2016). This is considered less efficient because when the tool calibration process is carried out in a different room, the calibration officer must also move the Personal Computer which is the unity of the Incubator Analyzer tool [14]. Further developed again portable tools using the Android display, but there is still a lack that there is no data storage so, the operator can not see the results of previous measurements by Imro'ah Dyah Sulistya and Lailly Kurniati (Year 2018). In the effective distance measurement bluetooth on the noise sensor has an average error of 0.44% at a distance of 10 m [15]. The use of technology in the field of communication has a huge change. With internet connectivity everything becomes easier and faster [16][17].

Based on the problems that have been outlined, the purpose of this study is to create an incubator analyzer design module with Internet of Things (IoT) based data delivery using a wifi connection so as to expand the benefits of internet connectivity [8][10] by comparing the results of parameter readings on modules with the reading results on incubator analyzer II [11], perform lost data [24]analysis at the time of measuring three parameters with modules using the Internet of Things (IoT) system [12][10]. To analyze lost data is done by comparing the results of LCD readings with readings of thingspeak [13] and analyze the speed of sending data from the results of reading the three parameters in the LCD display with the Internet of Things as the sender of data to the application view thingspeak [8] [25]. Delivery speed analysis is done when data is first received on the thingspeak application calculated using a stopwatch [9]. The purpose of this research is to create an Incubator Analyzer tool based on the Internet of Things (IoT) using Wi-Fi Connection by analyzing lost data and delivery speed which aims to expand the benefits of internet connectivity so that the ability to control, share data, and data storage can be easier [16][20][21].

## II. MATERIALS AND METHODS

### A. Experimental Setup

The study used INCU II as a comparison tool and used a baby incubator as a medium. The data collection is done by setting the temperature at 33 ° C and 35 ° C with data collection as much as 6 times.

#### 1) MATERIALS AND TOOLS

The study used the DHT22 sensor as a temperature sensor on the T1-T5 and humidity[22][23], and used the Max4466 sound sensor as a noise sensor. Components used include ESP32 [24][25] [26]as a microcontroller, 4x20 LCD and thing speak [27]application on laptops as a display with IoT-based as output[28].

2) EXPERIMENT

In this study, measurements of the output of the power supply circuit using a multimeter aimed to test the circuit whether it was in accordance with the incoming voltage of 12V. Next, measurements are taken on the output converter step down. Measurements are also taken on the output of the DHT22 sensor and the MAX4466 sensor.

B. The Diagram Blok

The following is a block diagram of the incubator analyzer tool module:

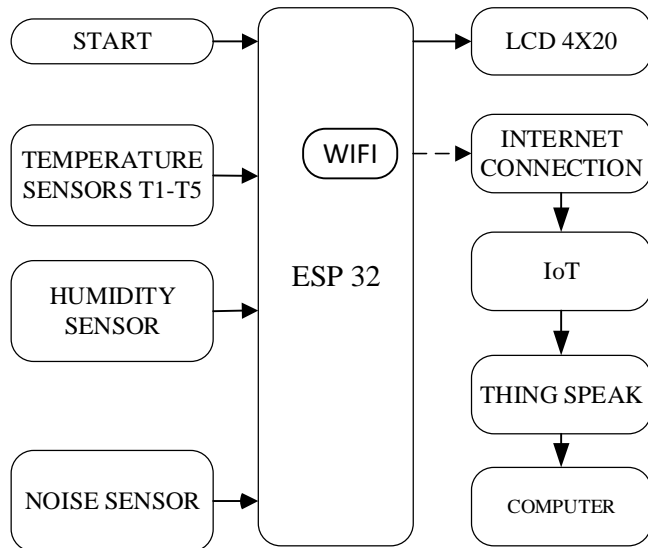


FIGURE 1. The diagram block of the incubator analyzer tool module

The diagram block of incubator analyzer tool module is shown in the FIGURE 1 first from the 12 V power supply, the voltage is lowered using Step Down to 5V to supply all circuits so that the T1-T5 temperature sensor, humidity, and noise will be active, then the reading data is forwarded on esp32 which is ruled by a program that is displayed to lcd using an internet connection and transmitted with an Internet of Things-based connection using an internet connection to the think speak display.

C. The flowchart

The flowchart of the incubator analyzer tool module is shown in the FIGURE 2 The Arduino program is based on the flow diagram as shown in the image above after initialization, the sensor will start the next reading processed by the program on ESP32, then the results of the reading will be displayed on the LCD 4x20 and sent using an internet-based internet connection of things to the thing speak display on the laptop.

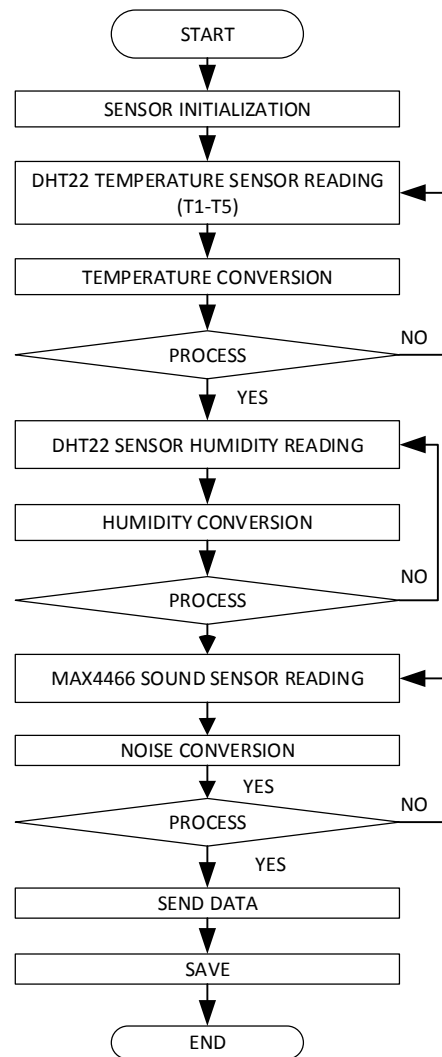


FIGURE 2. The flowchart of the incubator analyzer tool module

D. Analog circuit

The most important part of the study was the relationship between the three temperature, humidity and noise sensors with ESP32. This series is used to perform readings in the baby incubator room which later the results of the readings are displayed on a 4x20 LCD and the data will be sent using IoT to be displayed in the thing speak application on the laptop..

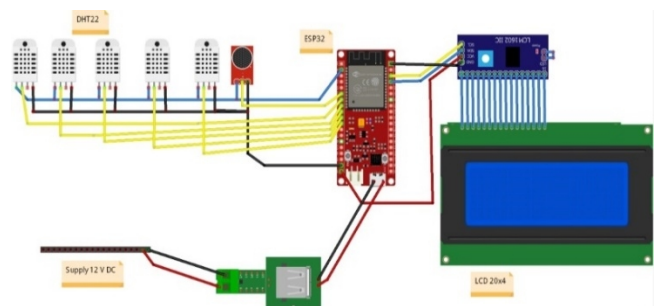


FIGURE 3. Module Circuit

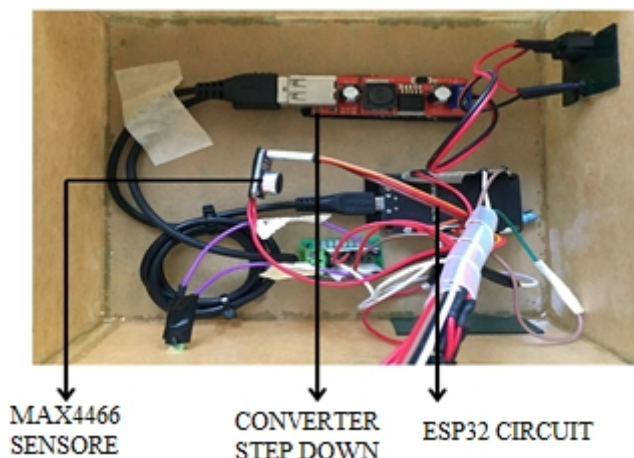
Seen in **FIGURE 3** This incubator analyzer module uses the ESP32 module. In this ESP32 module there is already a Wifi module so that it supports to create a system using the internet network. The authors used the DHT22 sensor as a temperature and humidity sensor as well as a MAX4466 sound sensor to measure noise at the time of data retrieval. The DHT22 sensor is able to read the temperature with a range of 30°C-60°C with a precision of  $\pm 0.5^{\circ}\text{C}$ , as well as humidity levels of 30% RH - 60% RH with the required power of 3.3 V to 6 Volts. The sound sensor for room noise reading with a measurable range of noise is 30dB-60dB and equipped with a 4x20 LCD as an output to display readings as well as a comparison in the thing speak application to find out lost data and delivery speed.

**III. RESULT**

In this study, the tool was conducted directly on a baby incubator. Researchers also compared the results of readings using a standard tool, incu II, as a comparison.



**FIGURE 4.** Test module tool with Incu II

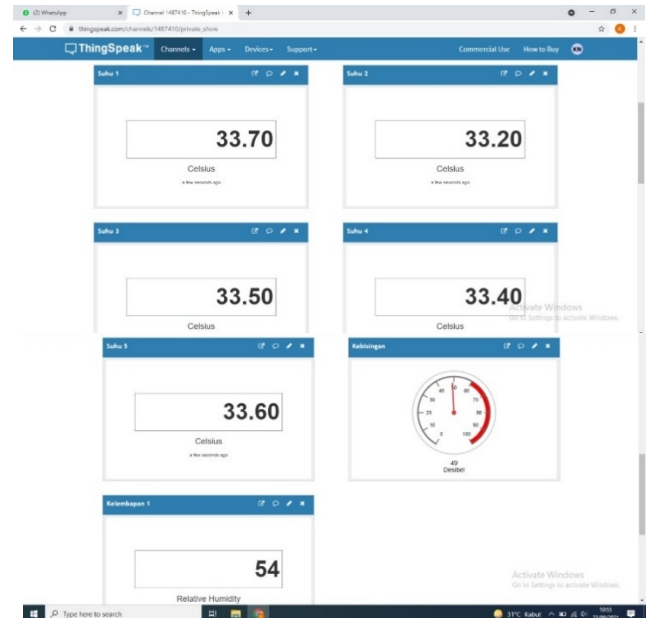


**FIGURE 5** Circuit of tool modules

**A. Calibrator Incubator Analyzer Module**

**FIGURE 4** shows at the time of testing the tool module with incu II comparison and in **FIGURE 5** shows the series of

incubator analyzer module modules including several supporting components, namely max4466 sensor, DHT22 sensor, step down converter, ESP32.



**FIGURE 6.** View on Thingspeak

**FIGURE 6** is a display on the thingspeak that displays measurement data which include temperature 1, temperature 2, temperature 3, temperature 4, temperature 5, humidity and noise presented in a view that is easily understood by the user.

1) MEASUREMENT READING RESULTS

The following is a performance measurement test to determine the value of parameter readings on the tool module with the incubator analyzer II calibration tool which was carried out 6 times at each point.

**TABLE 1**  
**Measurement Results at a Temperature of 33°C.**

	Tools	Average	Standard Deviation	Error (%)
T1	Module	33,6	0	0.59%
	Tools Comparison	33,8	7,78	
T2	Module	33,2	0,049	0%
	Tools Comparison	33,2	0,051	
T3	Module	33,5	0,040	0.29%
	Tools Comparison	33,4	0,054	
T4	Module	33,4	0,040	0.96%
	Tools Comparison	33,1	0	
T5	Modul	33,6	0,040	0.29%
	Tools Comparison	33,5	0,054	

**TABLE 1** shows the result of the measurement at the temperature setting of 33°C, the results of the smallest error percentage are 0% and the largest error is 0.96%.

**TABLE 2**

Measurement results at a temperature of 35°C.

	Tools	Average	Standard Deviation	Error %
T1	Module	35,1	0,075	0.28%
	Tools Comparison	35,2	0,054	
T2	Module	34,6	0,054	0.28%
	Tools Comparison	34,7	0,054	
T3	Module	35,2	0,051	0.28%
	Tools Comparison	35,1	0,051	
T4	Module	34,9	0,054	1.19%
	Tools Comparison	34,5	0,051	
T5	Module	34,4	0,054	4.1%
	Tools Comparison	35,9	0	

TABLE 2 shows the result of the measurement at the temperature setting of 35°C, the results of the smallest error percentage are 0.28% and the largest error is 4.1%.

**TABLE 3**

Humidity Measurement Results.

	Tools	Average	Standard Deviation	Error %
	Module	48	0	0,82%
	Tools Comparison	48,4	0,52	

TABLE 3 is the result of humidity measurements, the percentage error value is 0.82%

**TABLE 4**

Noise Measurement Results.

	Tools	Average	Standard Deviation	Error %
	Module	53,1	1,329	0,93%
	Tools Comparison	53,6	0,054	

For the noise measurement shown in TABLE 4, the error percentage value is 0.93%.

2) LOST DATA MEASUREMENT RESULTS

**TABLE 5**

Lost Data Testing

Program Requirements for 20 Seconds	
Amount of Data Sent	Amount of Data Received
10	10
20	20
30	30
40	40
50	50
60	60
70	70
80	80
90	90
100	100
1000	1000

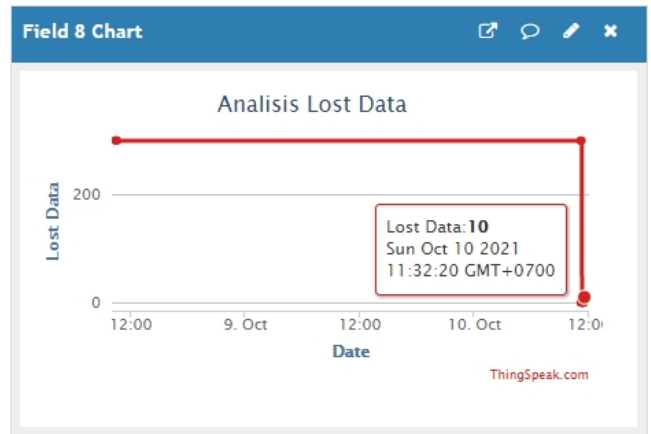


FIGURE 7 Lost Data Testing Result.

Lost data testing is done by sending as much data as specified and programmed to be received on thingspeak. From the results shown in TABLE 5, there is no missing data or lost data on reading thingspeak. FIGURE 7 shows a graph on thingspeak that displays the amount of data received.

3) DATA DELIVERY SPEED RESULTS

**TABLE 6**  
Data Delivery Speed Testing

Send Data	Data Accept	Delay (s)
10	10	24,39
20	20	34,07
30	30	35,30
40	40	24,64
50	50	33,94
60	60	21,70
70	70	34,25
80	80	26,36
90	90	24,00
100	100	24,26
1000	1000	32,00

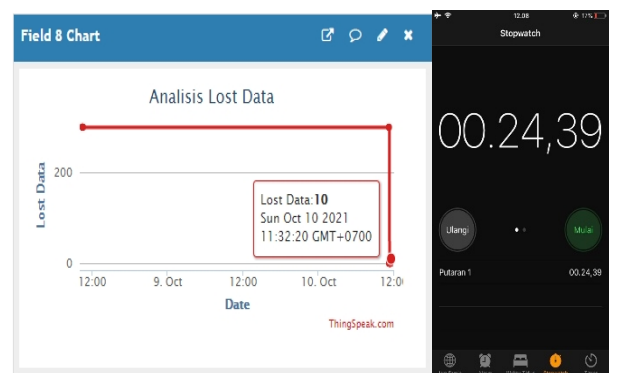


Figure 8. Data Delivery Speed Results.

The delivery speed testing data can be seen in FIGURE 8 where delivery time testing is done using a stopwatch. It can be seen from Table 6 that from the difference in data transmission time until the data is received on the thingspeak

application, there is a difference in delivery time which is the fastest time of 21.70s and the longest time of 35.30s.

#### IV. DISCUSSION

The design has been examined and test completely in this study and can display the value of 3 parameters including temperature, humidity, and noise. The data of each parameter value that have been obtained will be processed on the microcontroller. The results that have been processed can be displayed on a 4x20 LCD and sent using an Internet of Thing-based internet connection to the Thingspeak display on the computer.

Based on the results of measuring data from the module using incubator analyzer II calibration tool, at a temperature setting of 33°C shown in Table 1, the smallest error percentage is 0% and the largest error is 0.96%, and at a temperature setting of 35°C shown in Table 2, the smallest error percentage is 0.28% and the largest error is 4.1%. It is influenced by the temperature difference inside the baby incubator. From the results of humidity measurements shown in Table 3, the percentage error value is 0.82%. This value is still within the tolerance range because the percentage for error tolerance in calibration is 10%. For the noise measurement shown in Table 4, the percentage error value is 0.93%. From the results of the percentage error, this tool is still in requirements as a calibration tool with a noise range of 30dB-60dB. Based on the results of the lost data analysis shown in Table 5, the results obtained are the data sent with the same amount of data received or no missing data. So for testing the percentage of lost data is 0%. In Table 6, the results of testing the data transmission time, there is a difference in delivery time which is the fastest time of 21.70s and the longest time of 35.30s. Factors that affect the difference in delivery times include the internet network used. The delivery time test is carried out using a hotspot network that has previously been registered on the ESP32 device.

This study is a significant improvement because in the previous study it was less efficient because it used data transmission via bluetooth with limited distance and no data storage. In practical system, incubator analyzer requires the use of a Wi-Fi connection based Internet of Thing to analyze lost data and delivery speed so that it is easier to control, share data, and store data. Despite the increase in this study, the results of the sensor readings of this design still contained differences when compared to the standard tool. The placement of the sensor affects the results of parameter readings, so the sensor placement must match the measurement point. Also the thingspeak application has some limitations which can only display 8 readings for a minimum lag time of 20 seconds.

#### V. CONCLUSION

The purpose of this research is to create an Incubator Analyzer tool based on the Internet of Things (IoT) using Wi-Fi Connection by analyzing lost data and delivery speed which

aims to expand the benefits of internet connectivity so that the ability to control, share data, and data storage can be easier. This research shows that the design can display the value of three parameters including temperature, humidity, and noise, which can be displayed on a 4x20 LCD and sent using an Internet of Thing-based internet connection to the Thingspeak display on the computer. In summary, this study has been completely tested, and the accuracy of data results has been proven as described. Further experimental investigation are needed to developed by using a better noise sensor so that the results of the reading are more accurate, for sensor cables are recommended not to be too long because it can affect room temperature and sensor readings, also using applications other than thing speak for IoT display because in the application thing speak there are some limitations examples of channels only bus a displays 8, the reading is done once every 20 seconds.

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